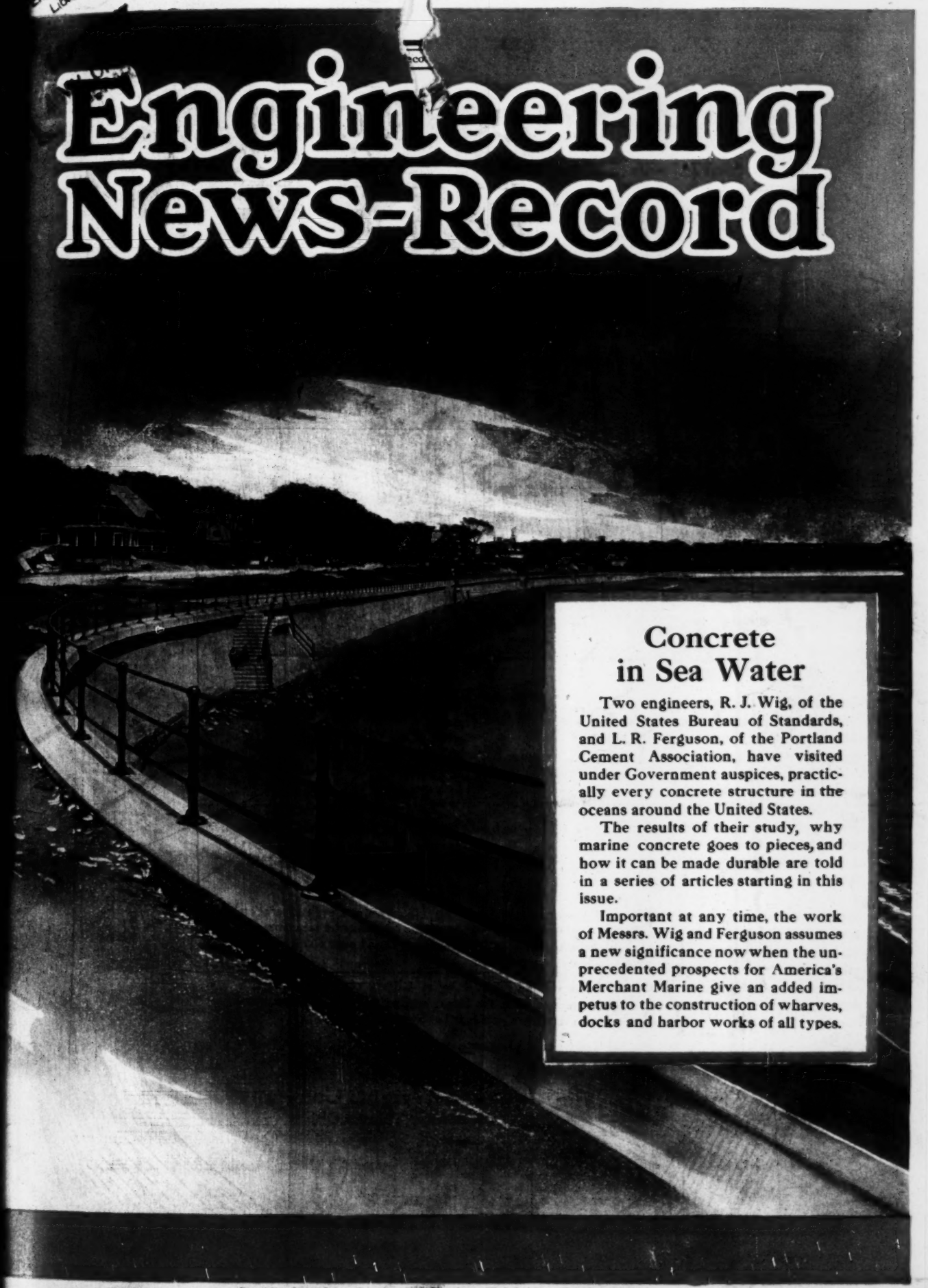
Engineering Library

Engineering News-Record



Concrete in Sea Water

Two engineers, R. J. Wig, of the United States Bureau of Standards, and L. R. Ferguson, of the Portland Cement Association, have visited under Government auspices, practically every concrete structure in the oceans around the United States.

The results of their study, why marine concrete goes to pieces, and how it can be made durable are told in a series of articles starting in this issue.

Important at any time, the work of Messrs. Wig and Ferguson assumes a new significance now when the unprecedented prospects for America's Merchant Marine give an added impetus to the construction of wharves, docks and harbor works of all types.

Cover Released by Courtesy of Jamison-Wright Co., Toledo, Ohio

Kreolite Lug Wood Blocks

"The Paving that's Saving"

Section of Kreolite Lug Wood Block Paving on Detroit-Superior High Level Bridge, Cleveland.

A Good Toe-hold for Horses on This 3.17% Grade

One of the reasons why Kreolite Lug Wood Blocks were selected for this bridge was on account of the grade, which is 3.17%. The lugs on these 4-inch blocks project one-quarter inch, giving the horses a much firmer footing than where a close-joint block is laid.

The ease of maintaining straight rows and even separation between blocks by aid of the lugs can easily be seen from the above view, as the work had progressed over 600 lineal feet when view was taken.

There will be no buckling or bulging of the floor on this bridge, for when the blocks expand the lugs will compress, automatically absorbing the expansion.

The Standard Engineering Company, Toledo, laid this floor.

The Jennison-Wright Company

2479 Broadway, Toledo, Ohio

New York Philadelphia Cleveland Cincinnati
Chicago St. Louis Toronto

A Consolidation of Engineering News and Engineering Record. Published by McGraw-Hill Publishing Company, Inc.

ENGINEERING NEWS-RECORD

A WEEKLY JOURNAL
DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

Volume 79 NEW YORK, THURSDAY, SEPTEMBER 20, 1917 Number 12

Governmental Action Is Called For

MONTHS ago the exemption of engineering students from military service was urged in these columns. The plea has remained unheard, and it needs forcible reiteration now in view of the technical colleges' appeal for more engineering students. High representatives of the Government, moreover, have made similar appeals individually. As yet there is no result. On the other hand, a recent order exempts medical students from service in the National Army. Upon our national engineering societies and engineers in responsible positions at Washington now rests the duty of securing corresponding recognition of the engineering profession's needs.

No Water-Works Consolidation in Sight

IN HIS presidential address before the annual convention of the New England Water-Works Association at Hartford last week, Mr. Saville disapproved of the project for a single national water-works association involving some form of consolidation between the New England and the American organizations. In other words, the prospect for a union between these two bodies is just as remote as it was last year and the year before that. However, the question is a sort of hardy perennial and will doubtless make its appearance at future conventions, in spite of the fact that there is an air of finality about President Saville's words. "With other organizations," said the head of the New England body, "we will work together gladly, and we welcome all water-works men to our membership. Careful consideration of our own particular needs and purposes, however, forbids any thought of combination with others."

Water Filtration Shows Engineers Ready to Serve

THE MANIFOLD resources at the command of the engineer to-day make him a potentially great public servant. How ample his resources are compared with thirty years ago is strikingly illustrated by George A. Johnson's paper on rapid sand filtration read at the Hartford convention of the New England Water-Works Association last week. The rapid or mechanical filters of the eighties, crude in every respect, were held to be all sufficient. Today, notwithstanding great refinements in mechanical filters, not merely pre-treatment but after-treatment as well is the rule. The engineer now has at his command a wide range of choice in purification processes and combinations and no lack of scientific knowledge to guide him in so fitting them to local conditions as to produce the best water at the least cost. The community which tolerates turbid or colored or typhoid-infected water today has only its own ignorance, negligence and parsimony to blame. In hundreds of other fields engineering and the engineer stand equally ready to put the resources of nature and art and science to the service of mankind.

Master and Service Water Meters Cut Waste

EVERY water-works superintendent knows that water meters applied to consumer's services cut waste. Not all have learned, or having learned have not convinced those who hold the purse strings, that for the most effective control of water waste master meters are required to record the water supplied to the various districts of the city and thus enable the waste to be traced. Mr. Killam's paper on service meters and water consumption in the Massachusetts Metropolitan Water District, printed on page 541, shows that with 69 venturi master meters and an increasing use of service meters in Boston and vicinity a remarkable reduction in consumption and waste has been effected in eight years. That much more needs to be done is evident from the high night consumption which still prevails. This high figure in the Boston district and persistently high figures of both day and night consumption in other places having a large percentage of taps metered was a source of wonderment at the Hartford convention before which Mr. Killam's paper was presented. Might not the general extension of the use of master meters reduce night consumption—which is mostly waste—and with it cut down to a more reasonable figure the high percentage of water unaccounted for in some of our fully metered American cities?

Federal Investigations Point the Way

THE SAFEST course for the experimental work of the Federal Government to take is one that will result in pointing a safe way for others to follow. We are referring, of course, to work which is primarily the

function of the state, the city, the private corporation and individual rather than of the Federal Government itself. A notable example of such trail blazing, made all the more notable by the way private industries are following it, is afforded by the tests of tannery wastes treatment made by the United States Public Health Service at Luray and Cincinnati, briefly outlined on page 553. The tanners became so much interested in these laboratory tests that they clubbed together and built a working unit at one of the tanneries in order to see for themselves whether successful laboratory tests under skilled direction could be equaled in a permanent plant without technical supervision. Experience is showing that they can be excelled! By experimenting at one place just long enough to point the way and then moving apparatus and men on to a fresh trade-waste investigation the Public Health Service economizes men and funds, multiplies its usefulness, and stimulates the manufacturers to take up the work themselves. It performs its function in pointing the way.

Road Shoulders Must Be Kept Clean

THE impression seems to exist among many road engineers that the chief purpose of the gravel, macadam or earth shoulders of a pavement is simply to furnish an additional width of roadway, losing sight of the fact that the principal function of the shoulders is to facilitate drainage. It is a common experience to see a considerable amount of money spent in building shoulders and to see the same shoulders a year or two later entirely grown over with grass and weeds. On a continuous trip by an editor of *Engineering News-Record* over the roads of New York, Ohio, Kentucky and Tennessee, in only one locality were highway officials found who made it a regular practice to keep the shoulders of concrete, brick and asphaltic pavements absolutely free from grass and weeds, giving a smooth, hard surface from the crown of the pavements to the centers of the side ditches. This was accomplished by regularly scraping the shoulders with a steel-bladed road machine or drag, adding new material and rolling where necessary and removing scraped up matter.

The improved appearance of highways thus treated can be easily conceived and would alone justify the slight expense involved with any highway department which fully appreciated the aesthetics of road building. Aside from any such consideration, however, the engineers of the New York State Highway Division, with headquarters at Rochester, where the work described has been done, state that it is entirely justifiable from the standpoint of reduction in maintenance costs.

It has been found by experience many times over that grass and weeds growing at the edge of a pavement retain moisture and are often responsible for failures which could have been avoided had the shoulders been taken care of. It should never be lost sight of that the surface drainage of any pavement is not complete until the water has been led far enough away to prevent it from seeping underneath the pavement.

Has Pound-Price Bidding Injured Bridge Engineering?

FOR the better part of a generation bridge construction has followed along well defined channels. The general lines of thought persisted without change and advance was in refinements of detail practice. Now that we appear to stand at the beginning of a new era, it is pertinent to ask whether this static condition of the past twenty years has any leading factors that can be discovered. The elimination of such elements may bring about better conditions for progress in the coming era. A generation ago a new method of contracting for railway bridges was introduced. Bridge building companies until then had submitted designs and lump-sum bids. Their competition was as much in design as in economy of shop and erection work. Looking back to the earlier days, one may observe how the names of large bridges are commonly connected with the names of prominent bridge building concerns. The engineers of those concerns were the creators of the structures. Their individuality is still reflected in the economy, life and appearance of the bridges. This state of affairs no longer exists. The practice of pound-price bidding has altered it.

Under the pound-price practice the purchaser's engineers fix the general layout and type of design, and then contractors are asked for bids per pound of steel in the finished structure. This method affords the contractor no opportunity to introduce his own ideas and experience. He has no inducement to save weight and reduce the total cost. He is no longer the creator of the structure that he builds. On the contrary, he is under the commercial necessity of putting as much metal as possible into the finished structure and saving labor wherever possible in order to live up to the pressure of a pound-price reduced to the last hundredth of a cent a pound.

In the actual application of the method there is much opportunity for the contractor to work to his own advantage, and—experience shows this, despite purchaser's plans and specifications—little opportunity to suggest or secure modifications of design for improving the quality of the bridge. The purchaser is reluctant to entertain proposals involving ideas differing from his, for he is apt to hold that his own idea if not better is at least fully equal to the contractor's. On the other hand, effort to reduce total weight in the detailing is virtually non-existent, for only rarely is the purchaser able to show how metal is to be saved, while the pressure of necessity leads the contractor to checkmate any endeavors in this direction.

In setting forth these conditions, *Engineering News-Record* is well aware of the imperative reasons that led to the abandonment of lump-sum bidding. Abuses had come to flourish that were serious indeed, and "skinning" of details, as was by no means rare in the early '90's, demanded radical reform. The waste of effort involved in the preparation of numerous plans, all but

one of which were to be discarded, was a contributing factor, though of perhaps secondary importance. It seemed inevitable that competition between different bridge building contractors should be put upon a definite, business-like basis, where the relative economy of work of the several bidders would not be obscured by radical differences in design. All these reasons have force today as they did twenty-five years ago. Yet they do not essentially modify the meaning and definiteness of the picture above presented.

The case presents a distinct and important problem to all who are concerned with bridge construction. It seems clearly evident from a careful survey of the conditions as they developed during the past generation that pound-price bidding has not only led to the expenditure of much more money in bridges than the purposes required, but has also laid a paralyzing hand on the development of the bridge designer's art. What seems called for under the conditions is a return to such a form of competitive bidding as will stimulate originality and resource in bridge design. We need have little apprehension that bridge engineers of today —when the profession is on a very high plane of development indeed—will allow the same abuses to spring up that, many years ago, led to the adoption of the pound-price method.

The Magic of the Cantonments

LAST week's news brought from the War Department the statement that two of the sixteen cantonments for the National Army are 100 per cent. completed and that the others, except two where local conditions delayed a fair start, are well along toward completion. By the time these lines appear, it is probable that the list of finished camps will contain several additions. Progress is rapid on these jobs.

It has been a race against time, and the American contractor has won. A new chapter has been added to construction history, a chapter that suggests feats of legerdemain on a colossal scale. The contractor, in the role of magician, makes a few swift passes over a tract of wilderness and a city for 40,000 people springs up.

Yet it is no shallow trick of stagecraft. There is no illusion, no painted canvas, no ingenious manipulation of lights to create a semblance of strength and stability. Everything is real, substantial. The promise of three months ago is a fact of today. Then acclaimed the greatest building program of history, now it is the fulfillment of a nation's dream and wish.

Even to us, the engineers and contractors of the country, accustomed to the planning and direction of huge enterprises, the accomplishment creates wonderment. Try as he will, the layman can not comprehend what has been done. It is difficult enough for those familiar with construction methods to get a clear appreciation of the work without having visited a number of the cantonments while progress was at its highest.

The problem has been one of organization primarily—of creating in a few days machinery to handle huge quantities of materials and huge labor forces. Yet the American contractor and the American engineer have been found equal to the stupendous task set for them.

Moreover, the results reported by the War Department are an unqualified endorsement of the wisdom of the policy which cast aside the red tape of normal government methods, picked the right men for the work and gave them unlimited authority.

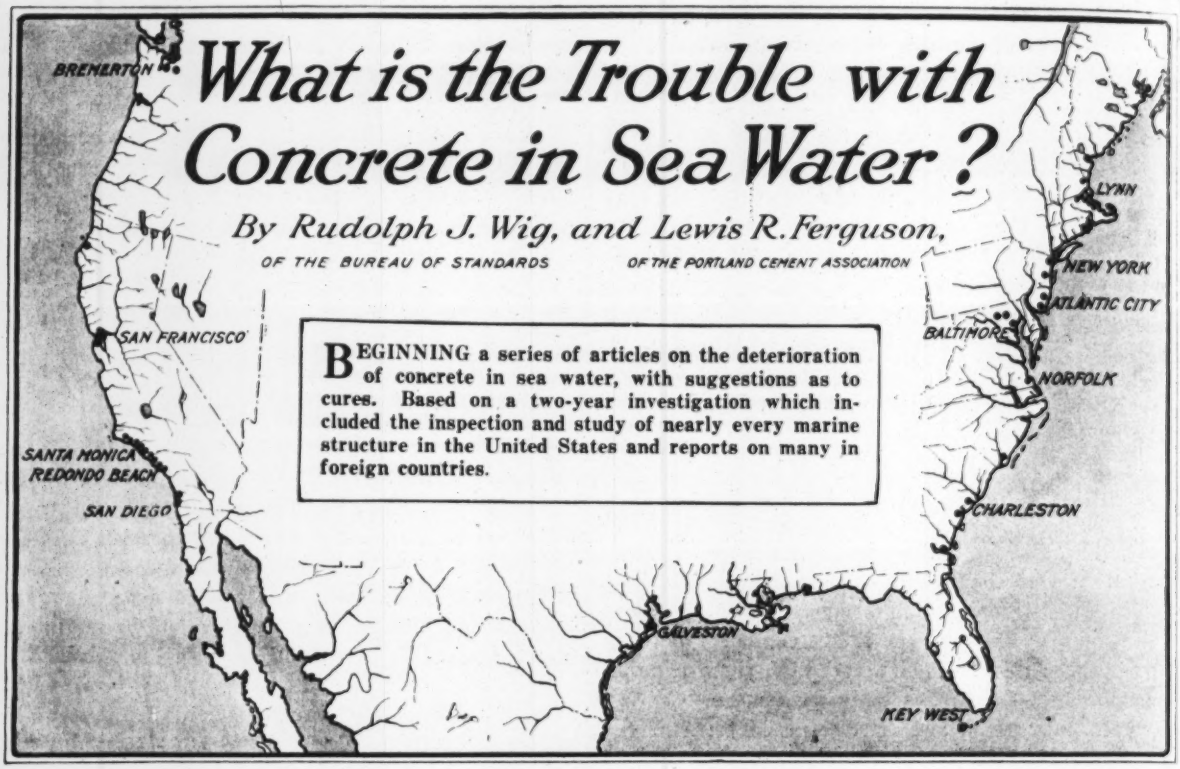
When the history of the war is written, we trust that the era of preparation will not be slighted—for the story of the cantonments is well worth passing down to future generations of Americans.

Facts on Sea-Water Concrete

THE literature relating to the use of concrete in sea water is extensive. For instance, in one of the most elaborate recent reports on the subject, by W. W. Pagon of Baltimore, 145 references to related articles are listed. Yet it is safe to say that a careful reading of all these references would not be a certain guide as to the possible use of plain or rei nforced concrete where exposed to sea action, because the premises of each article are either pure theory or else observation of a limited number of structures subjected to a limited number of actions.

In the study of the behavior of concrete the safety of conclusions is almost proportional to the number of structures under observation. The elements that go to make up concrete or affect its wear are so many and so diverse that it is always easy to shift blame for failure upon some element not favored by the investigator, particularly when an individual instance is under discussion. For this reason, if for no other, the articles by Messrs. Wig and Ferguson on concrete in sea water, which start on page 532 of this issue, have commanding authority. Where other investigators have seen a dozen structures or studied a score of reports, these have closely inspected hundreds, and the inspection has been accompanied by complete historical records of the conditions of manufacture and material. The result is that they have a background of fact which permits deductions not to be controverted by the isolated instance.

Just what these deductions are will be brought out in future issues. In some ways they are repetitions of the past, in others they are radically new. Old or new, however, there is no doubt that they will have a marked influence on this important field of concrete construction. Concrete is too admirably adapted for all marine structures to be discarded for that use because of frequent and all-too-evident failures. But those who use it must have a proper appreciation of the danger surrounding its use and must be sure that, both in design and construction, they treat the pervasive and persistent sea water with the deference it deserves. At some future time probably this report will have official publication in full. *Engineering News-Record* deems itself fortunate to be able to present to its readers now a complete résumé of this important engineering investigation.



What is the Trouble with Concrete in Sea Water?

By Rudolph J. Wig, and Lewis R. Ferguson,
OF THE BUREAU OF STANDARDS OF THE PORTLAND CEMENT ASSOCIATION

BEGINNING a series of articles on the deterioration of concrete in sea water, with suggestions as to cures. Based on a two-year investigation which included the inspection and study of nearly every marine structure in the United States and reports on many in foreign countries.

THE durability of concrete in sea water has been a subject of absorbing interest to engineers for many years. Numerous isolated structures have been examined and many theories have been advanced, but it is safe to say that there is no unanimity of opinion among engineers as to the condition of marine concrete or as to the causes of deterioration, if such deterioration is admitted.

It has been the privilege of the writers in the past two years to make a personal examination of nearly every concrete structure in sea water in the continental limits of the United States, besides a great number in Canada, Cuba and Panama. These structures are tabulated herewith. In addition, detailed information has been secured through American consular offices on the methods of construction and present condition of concrete works in various harbors all over the world. As a result of this study, the writers are convinced that they have secured data which warrant conclusions of great importance to the engineering profession. In many cases the conclusions drawn are at variance with common engineering practice, which is shown to be incorrect by the comprehensive evidence at hand, and some radical changes in design and methods of construction are suggested. These conclusions account for the almost universal progressive decomposition of concrete in sea water and lead to suggestions for the improvement of concrete making and placing, which should insure the permanency of a material that otherwise is so well suited for many needed ocean structures.

It is the intention to outline some of the studies made and to abstract the conclusions in a series of articles of which this is the first. These articles will demonstrate that (1) permanency for plain and reinforced concrete can be obtained under most, but not all, conditions of exposure; (2) all concrete in sea water, both in northern and southern climates, is subject to chemical disintegration under certain conditions; (3) *reinforced* concrete of excellent quality, designed according to recommendations of engineering societies and present practice, is subject to relatively rapid deterioration in most localities; (4) the materials and methods used in construction have an important bearing on the durability of concrete and the design and the protection provided influence greatly the permanency of the structure.

The accompanying map, indicating the structures examined, will give some idea of the wide scope and comprehensive limits of the investigation. The fact that the number of structures examined has been so large is of much importance. Any investigation which is confined to a limited section of the country would lead one to draw very erroneous conclusions, if deductions of a general character were attempted. Such general deductions can only be made after a survey of broad scope covering sections where widely varying climatic and physical conditions exist.

In addition to this, the facts must be known about the methods used in construction, the materials of which the concrete was made, the amount of water used in mixing, the past and present conditions of exposure, the salt content of the water, and in fact all the details which can only be secured by a careful examination of the structure, by studying the specifications, drawings, records and photographs made during construction, and by interviewing those actually in charge of the work.

This information was secured by the writers in conformity with a detailed questionnaire, and the data thus obtained frequently offered the true explanation of existing conditions. Without this detailed knowledge, entirely wrong conclusions might easily have been drawn,

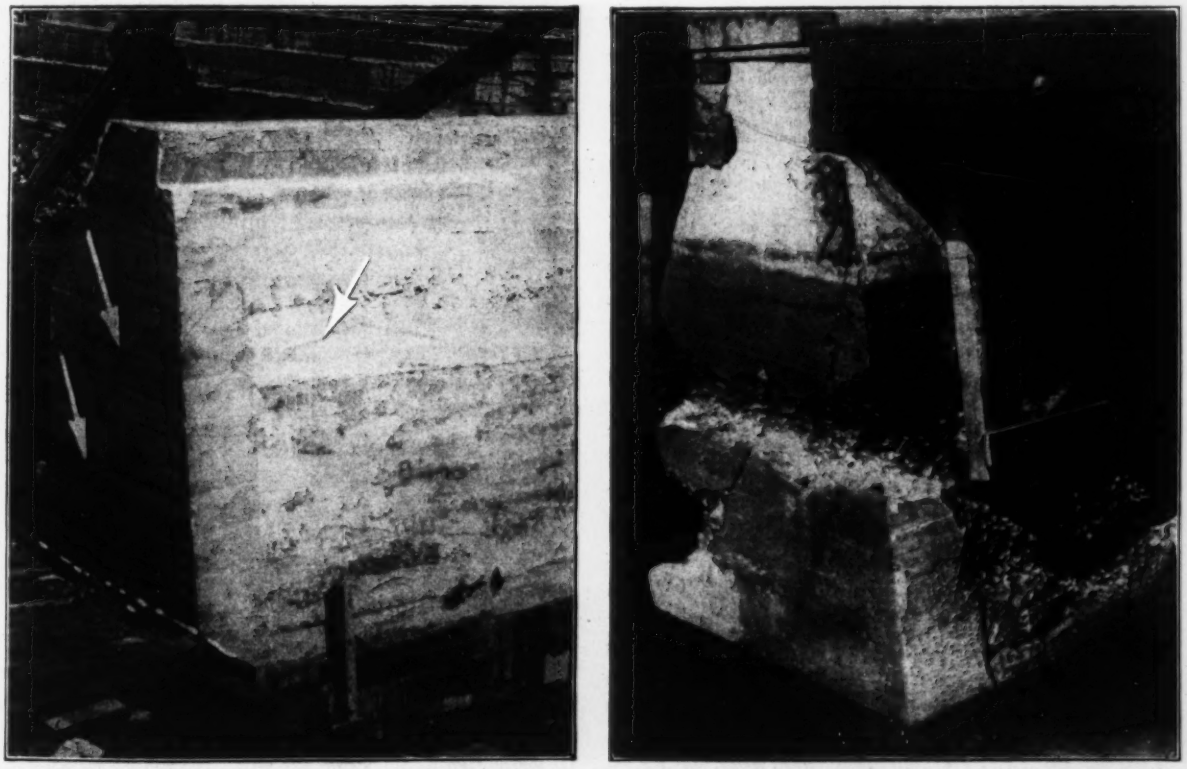
and in fact this was found to be the case in a number of instances. Of course, it is often difficult to unearth the actual facts about the building of a structure ten or fifteen years old; unless these facts appear in the records or can be seen from a progress photograph they must be secured from the engineers and inspectors who had charge of the work. If any defects are now in evidence or if the concrete is deteriorating these men feel a sense of responsibility and sometimes are loath to tell what actually happened during the construction. The conditions under which the present investigation was made were extremely fortunate, for to the greatest possible extent were all the facts made available.

One or two examples of the utility of historical references may be cited. In the right-hand view herewith is shown a concrete wall in a state of progressive disintegration. If one were to examine that wall in the light of present information there might be some difficulty in understanding or analyzing the reasons for the partial failure. However, an examination of the left-hand view, which is of that wall 12 years before, throws great light on the trouble. It will be noticed in the early view that construction seams were formed, as indicated by the arrows. The wall was built dry within a cofferdam, and although perfectly obvious the seams do not look particularly dangerous. A study of the later picture, however, shows that the deep erosion of the sea water has taken place right along these construction seams.

There is a concrete pier along the New England coast which has been the subject of a number of investigations and reports. This pier was built about fifteen years ago, and even before it was completed there were signs of deterioration. This continued and before a great while endangered the stability of some parts of the structure. From the construction photographs it was evident the concrete was mixed dry. The inspector who had charge of the work was the one who offered the most substantiating evidence to this effect. He said: "Yes, the concrete was dry, very dry. One day I tripped and fell into a freshly mixed batch, and when I got up I brushed the dust off my clothes." In another case an inspector testified to the fact that a tremie had not been used in its normal and expected fashion, but merely as a chute, permitting the concrete to settle from its bottom through 8 ft. of water.

It is not the intention of these articles to demonstrate that concrete cannot be used for marine structures. On the contrary, it is the opinion of the authors that it is a most economical material to be used if it is made so as to successfully resist sea-water action, and it is their opinion that it can be made so. The articles will, however, illustrate in an emphatic manner the rapid deterioration which results from the use of too little or too much water in mixing concrete, the origin and development of deterioration from normal construction seams which are common to most concrete work, the protecting influence of adequate fender systems or granite facings, the need for radical modification in the design of reinforced-concrete marine structures, and the conditions under which sea water can be used in mixing the concrete without detrimental effect.

It is a fact that plain concrete, if exposed to physical abrasion, will very soon commence to disintegrate, due to chemical action. The evidence collected by the authors shows that reinforced concrete will, in practically any



IN THE LEFT-HAND VIEW ARROWS INDICATE CONSTRUCTION SEAMS IN WALL IMMEDIATELY AFTER CONSTRUCTION. THE RIGHT-HAND VIEW SHOWS HOW THESE SEAMS WERE ATTACKED BY SEA WATER IN 12 YEARS

CONCRETE STRUCTURES IN SEA WATER ON THE AMERICAN COASTS

No.	Location	Owner	Type
1	Vancouver, B. C	G. N. Ry	Wharf, precast cylinder shells filled in place, concrete piles and deck.
2	Vancouver, B. C	Canadian Gov't	Wharf, gravity wall on wood crib with concrete facing.
3	Vancouver, B. C	Burns Co., Ltd.	Concrete building foundation
4	No. Vancouver, B. C.		Ferry wharf, precast piles, wood deck.
5	No. Vancouver, B. C. (Lonsdale)		Quay wall, precast slabs and piles.
6	Victoria, B. C	Canadian Gov't	Breakwater, mass concrete on rubble mound.
7	Victoria, B. C	Canadian Gov't.	Wharves, reinf. concrete cribs, gravity wall.
8	Victoria, B. C.	Municipal	Counterfort sea wall.
9	Victoria, B. C	Municipal	Sea wall, gravity type, concave face.
10	Bremerton, Wash.	U. S. Navy Dept.	5 gravity quay walls.
11	Bremerton, Wash.	U. S. Navy Dept	3 counterfort quay walls.
12	Bremerton, Wash.	U. S. Navy Dept.	Combination cantilever, counterfort and revetment.
13	Bremerton, Wash.		Wharf, cylinders cast in place, concrete deck.
14	Bremerton, Wash		Wharf, precast cylinder shells filled in place, concrete deck.
15	Seattle, Wash	Seattle Elec. Co.	Gunite jacket on wood piles.
16	Humboldt Bay, Cal.	U. S. War Dept.	Jetty, precast piles with conc. cap.
17	Mare Island, Cal	U. S. Navy Dept.	16 gravity quay walls.
18	Mare Island, Cal	U. S. Navy Dept.	Counterfort quay wall.
19	Mare Island, Cal.	U. S. Navy Dept.	Cantilever quay wall.
20	Pt. Richmond, Cal.	Standard Oil Co.	Wharf, concrete jacket over wood piles.
21	San Francisco, Cal.	U. S. War Dept.	Cellular quay wall.
22	San Francisco, Cal.	U. S. War Dept.	2 wharves, cylinders cast in place, concrete deck.
23	San Francisco, Cal.	S. F. & O. T. R.R.	Wharf Holmes conc. cylinder wood pile core, wood deck.
24	San Francisco, Cal.	State	8 wharves, cylinders cast in place, precast piles and concrete deck.
25	San Francisco, Cal.	State	Wharf, cylinders cast in place on wood piles.
26	San Francisco, Cal.	State	2 wharves, precast piles.
27	San Francisco, Cal.	State	Wharf, Koetitz precast shells over wood piles, wood deck.
28	San Francisco, Cal.	State	8 wharves, Holmes concrete cylinder, wood piles, wood deck.
29	San Francisco, Cal.		Wharf Holmes steel shell conc. cylinder wood pile core., wood deck.
30	San Francisco, Cal.		2 gravity sea walls.
31	Santa Monica, Cal.	Municipal	Pleasure pier, precast piles, wood deck.
32	Santa Monica, Cal.	Nat. Goodwin	Pleasure pier, precast piles, wood deck.
33	Venice, Cal	Municipal	Pleasure pier, Holmes concrete cylinder pile core.
34	Hermosa Beach, Cal	Municipal	Pleasure pier, precast piles, wood deck.
35	Redondo Beach, Cal	Municipal	Pleasure pier, precast concrete piles, concrete deck.
36	Redondo Beach, Cal	Pac. L. & P. Co.	Wharf, cylinders cast in place in steel shell.
37	Ocean Park, Cal.	Fraser	Pleasure pier, precast piles, wood deck.
38	Long Beach, Cal.	Municipal	2 bulkhead walls, sheet pile.
39	Long Beach, Cal.	Municipal	Pleasure pier, Holmes conc. cylinder, wood pile core.
40	Long Beach, Cal.	Municipal	Pleasure pier, precast piles, wood deck.
41	San Pedro, Cal.	U. S. War Dept.	Breakwater anchor blocks and test blocks.
42	San Pedro, Cal.	O. H. D. & W. Co.	Wharf, precast piles, wood deck.
43	San Pedro, Cal	Municipal	Wharf, precast piles, concrete deck.
44	Huntington Beach	Municipal	Pleasure pier, precast piles, wood deck.
45	San Diego, Cal	Municipal	Wharf, cylinders cast in place on precast base, concrete deck.
46	San Diego, Cal	Spreckles Bros	Concrete jackets over wood piles.
47	Ft. Rosecrans, Cal.	U. S. War Dept.	Wharf, concrete jackets on wood piles.
48	Ft. Rosecrans, Cal.	U. S. War Dept.	Wharf, precast piles, wood deck.
49	San Diego, Cal	U. S. Navy Dept.	Wharf, steel shells filled concrete, wood deck.
50	Port Arthur, Texas	Gulf Refining Co.	Wharf, precast piles, concrete deck.
51	Galveston, Texas	Municipal	Gravity type sea wall.
52	Galveston, Texas	Municipal	Causeway precast piles and revetment.
53	New Orleans, La.	U. S. War Dept.	Concrete blocks, S. W. jetty, Mississippi River.
54	Ft. Morgan, Ala	U. S. War Dept.	Revetment and sea wall.
55	Havana, Cuba	Luz Ferry House	Wharf precast Chenoweth piles, conc. jackets on wood piles.
56	Havana, Cuba	Casa Blanca Coal	Wharf precast Chenoweth piles, concrete deck.
57	Havana, Cuba	United Rys. Co.	Tallapiedra wharf, precast Chenoweth pile, conc. deck
58	Havana, Cuba	Gas. & Elec. Co.	Tallapiedra wharf, precast piles, concrete deck.
59	Havana, Cuba	P. & O. S. S. Arsenal.	Wharf precast piles, concrete deck.
60	Havana, Cuba	Regla Coal Co	Wharf, precast cylinder shells filled in place, conc. deck.
61	Havana, Cuba	Ports Company	Sea wall gravity.
62	Havana, Cuba	Yacht Club	Wharf, precast piles, concrete deck.
63	Havana, Cuba	United Rys. Co.	Paula wharf, Holmes concrete cylinders wood pile core, concrete deck.
64	Key West, Fla.	U. S. Navy Dept.	2 gravity retaining and foundation walls.
65	Key West, Fla.	U. S. Navy Dept.	Wharf and quay wall, precast piles, concrete deck and apron.
66	Key West, Fla.	U. S. Navy Dept.	Wharf, precast cylinder shells filled in place, wood deck.
67	Key West, Fla.	U. S. War Dept.	Wharf, Braxton precast pile, wood deck, breakwater gravity wall.
67a	Key West, Fla.	U. S. War Dept.	Breakwater gravity wall
68	Key West, Fla.	U. S. War Dept.	Foundation gravity wall.
69	Key West, Fla.		Quay wall gravity.
70	Key West, Fla.	Fla. E. C. Ry.	39 projects, 394 unreinforced bridge piers.
71	Key West, Fla.	Fla. E. C. Ry.	1,520 unreinforced viaduct piers.
72	Key West, Fla	Fla. E. C. Ry.	180 reinforced bridge piers.
73	Brunswick, Ga	A. B. & A. Ry.	2 wharves, precast piles, wood deck.
74	Brunswick, Ga	A. B. & A. Ry.	Quay wall sheet pile.
75	Port Royal, S. C.	U. S. Navy Dept.	3 sea walls, gravity.
76	Port Royal, S. C.	U. S. Navy Dept.	Wharf, steel shells filled concrete, wood deck.
77	Charleston, S. C.	U. S. Navy Dept.	Quay wall, gravity.
78	Charleston, S. C.	U. S. Navy Dept.	Wharf, cylinders and precast piles, concrete deck
79	Charleston, S. C.	U. S. Navy Dept.	2 wharves, precast piles, concrete deck.
80	Charleston, S. C.	U. S. Navy Dept	Foundation precast piles.
81	Charleston, S. C.	U. S. Treas. Dept.	Quay wall gravity.
82	Charleston, S. C.	Municipal	Sea wall gravity, with reinforced apron.
83	Charleston, S. C.	Bu. lighthouses	4 beacons, precast piles and concrete deck.
84	Wilmington, N. C.	Bu. lighthouses	32 beacons, precast piles and concrete deck.
85	Norfolk, Va.	U. S. Navy Dept.	7 quay walls, gravity, with precast sheet piles.
86	Norfolk, Va.	U. S. Navy Dept.	Quay wall, cellular, with precast sheet piles.
87	Norfolk, Va.	U. S. War Dept.	Quay wall, counterfort.
88	Annapolis, Md.	U. S. Navy Dept.	Quay wall, counterfort, on precast S.P.S. filled in place
89	Annapolis, Md.	U. S. Navy Dept.	Wharf, precast piles, concrete deck.
90	Sparrows Point, Md.	Bethlehem Steel Co.	Quay wall, precast sheet piles
91	Baltimore, Md.	Municipal	3 wharves, precast sheet piles.
92	Atlantic City, N. J.	Young's Million Dollar	Pleasure pier, steel and wood shells filled in place, conc deck.
93	Atlantic City, N. J.	Young's Old	Pleasure pier, precast piles, wood deck.
94	Atlantic City, N. J.	Steeplechase	Pleasure pier, steel shells filled in place, wood deck.
95	Atlantic City, N. J.	Steel	Pleasure pier, steel shells filled in place, P.C.P.W.D.
96	Atlantic City, N. J.	Garden	Pleasure pier steel shells filled in place, precast piles, C. D
97	Atlantic City, N. J.	Municipal	Foundation, precast piles.
98	Atlantic City, N. J.	Municipal	2 foundation gravity walls.
99	Atlantic City, N. J.	Gardener's Basin	Bulkhead wall, precast sheet piles.
100	Atlantic City, N. J.	A. C. & S. Ry.	Bridge pier.
100a	Deal, N. J	Private	Pleasure pier, precast piles, concrete deck.
101	Long Branch, N. J.	Municipal	Pleasure pier, precast piles, concrete deck.
101a	Ocean City, N. J.	A. C. & S. Ry.	Bridge pier.
102	Ocean City, N. J.	Municipal	Highway bridge pier.
103	New York, N. Y.	Bu. D. & F.	Bulkhead wall, precast blocks, granite face (21 sec.).
104	New York, N. Y.	Bu. D. & F.	Wharf, multiple arch.
105	New York, N. Y.	U. S. War Dept.	Sea wall, granite gunite pointing, foundation conc.
106	New York, N. Y.	U. S. War Dept.	2 sea walls, gravity.
107	New York, N. Y.	U. S. War Dept.	Patchogue Jetty, concrete on stone substructure.
108	New York, N. Y.	U. S. War Dept.	3 cable tanks.
109	New York, N. Y.	U. S. Navy Dept.	7,000 ft. quay wall, gravity.
110	New York, N. Y.	U. S. Navy Dept.	3 quay walls, gravity, faced with granite.
111	New York, N. Y.	U. S. Navy Dept.	1 quay wall, gravity, precast blocks.
112	New York, N. Y.	U. S. Navy Dept.	Quay wall, gravity, on brick arch culverts.
113	New York, N. Y.	U. S. Navy Dept.	3 wharves, reinforced conc pedestals on wood decks.
114	Ft. Adams, R. I.	U. S. War Dept.	Sea wall, gravity.
115	Newport, R. I.	U. S. War Dept.	Sea wall, gravity.
116	Newport, R. I.	U. S. Navy Dept.	2 foundation piers, unreinforced.
117	Newport, R. I.	U. S. Navy Dept.	2 floats, reinforced.
118	Newport, R. I.	U. S. Navy Dept.	Wharf reinforced pedestals, wood deck L. W.
119	Newport, R. I.	U. S. Navy Dept.	Foundation under granite sea wall.
120	Hingham, Mass.	U. S. Navy Dept.	Quay wall.
121	Boston, Mass.	U. S. Navy Dept.	Wharf, multiple arch unreinforced.
122	Boston, Mass.	U. S. Navy Dept.	Quay wall, granite face.
123	Boston, Mass.	U. S. Navy Dept.	Foundation wall, granite face
124	Boston, Mass.	U. S. Navy Dept.	Bulkhead wall.
125	Boston, Mass.	B. & M. R. R.	Quay wall, gravity, wood crib with concrete face.
126	Boston, Mass.	Municipal	Bridge pier, unreinforced.
127	Boston, Mass.	Edison Elec. Co.	Bulkhead wall, gravity.
128	Ft. Heath, Mass.	U. S. War Dept.	Sea wall, gravity.
129	Winthrop, Mass.	Met. P. Com. (State)	Sea wall, gravity.
130	Lynn, Mass.	Met. P. Com. (State)	Sea wall, gravity.

No.	Location	Owner	Type
131	Revere Beach, Mass.	Met. P. Com.(State)	Stepped revetment, reinforced.
132	Point of Pines, Mass.	Met. P. Com.(State)	Stepped revetment, reinforced.
133	Rockport, Mass.	U. S. War Dept.	Breakwater, unreinforced blocks.
134	Portsmouth, N. H.	U. S. Navy Dept.	Quay wall, multiple arch unreinforced.
135	Portland, Me.	U. S. War Dept.	2 sea walls, gravity.
136	Portland, Me.	U. S. War Dept.	Wharf precast blocks, mass concrete substructure.
137	St. John, N. B.	Canadian Gov't	Quay wall, gravity.
138	St. John, N. B.	Canadian Gov't	Quay wall, gravity.
139	St. John, N. B.	Canadian Gov't	Breakwater concrete on granite substructure.
140	Nova Scotia	Prov. Govt.	60 highway bridge piers.
141	Nova Scotia	D. A. R. Ry.	10 bridge piers.
142	Nova Scotia	D. A. R. Ry.	2 culverts.
143	Nova Scotia	Intercol. Ry.	Wharf precast piles, concrete deck.
144	Nova Scotia	Intercol. Ry.	Quay wall, precast cellular blocks, granite face.
145	Nova Scotia	Canadian Gov't	Quay wall, gravity.
146	Nova Scotia	H. & S. W. Ry.	3 bridge piers.

climate, begin in a short time to fail above sea water due to the absorption of the sea water or penetration of sea air bearing chlorine to the reinforcement. This reinforcement soon rusts and the concrete cracks.

Engineers recognize that deterioration of unreinforced concrete takes place in certain localities, but the opinion is held by many that the trouble is confined to the North, where freezing conditions exist. Such is not the case. Both chemical and physical disintegration of concrete structures are in progress along all our sea coasts, although the action is greatly accelerated in the case of plain concrete where low temperatures exist and in the case of reinforced concrete where high temperatures exist.

In pointing out the conditions which have led to deterioration in some of the concrete structures, there is no intention to criticise those who were in charge of design and construction, for most of it accorded with current engineering principles. The only reason for calling attention to the causes for deterioration is to show how such trouble can be obviated in the future and more durable structures built of concrete.

Secret Garbage-Reduction Process Will Be Tested

THE COMPLICATED garbage situation at St. Louis, noted in *Engineering News-Record*, Aug. 30, p. 429, has been cleared for a while by the passage of an ordinance by the Board of Aldermen authorizing the Board of Public Service to execute a form of contract approved by it July 20. This contract provides that Joseph M. Hirsch, of Chicago, will build and operate for three months a 20-ton demonstration garbage-reduction plant which will dispose of garbage by a secret chemical process devised by him "without creating any garbage or other offensive odors which may be detected outside the building containing the plant," that the test plant will demonstrate that reduction works large enough to treat all the garbage of St. Louis will yield a revenue "at ordinary market prices" of not less than $3.60 per ton of green garbage, without considering capital charges, and that the experimental plant will further demonstrate that a 300-ton-per-day plant using the Hirsch process can be built for $150,000, not including site, building and foundations. The revenue of $3.60 per ton is based on an estimate of the Board of Public Service of the yield from a Cobwell-process plant which the board recently advised that the city build. The Hirsch contract provides that if the data from a working Cobwell plant show that $3.60 is in error then that figure "shall be modified in a proportionate degree."

Details of Agreement

Adjudication of the Hirsch assertions is to be made by a committee consisting of the comptroller of St. Louis, the president of the Board of Public Service, and two persons selected by Mr. Hirsch—or, in case of non-agreement, by an arbitrator chosen by the four.

The city agrees to supply a site for the test plant, to pay $15,000 for the installation, and also to pay $2000 for operation, besides supplying steam to operate the plant and paying 10c. a ton of green garbage for chemicals, but the city is to have all revenue from the sale of by-products. In case Mr. Hirsch does not demonstrate his claims he is to return to the city the $17,000 paid for installation and operation. The contract provides for a security bond of $17,000 to be given by Mr. Hirsch.

All the foregoing provisions lead up to the real object of the contract, which is an agreement on the part of the city that if the adjudication committee or the arbitrator rule that Mr. Hirsch has demonstrated his claims then "the Board of Public Service shall prepare and recommend for passage an ordinance providing for the construction" of a Hirsch system garbage-reduction plant, the ordinance to provide that the city shall pay Mr. Hirsch a royalty of 25c. a ton of garbage disposed of for a period of 10 years, and that the city shall be protected by Mr. Hirsch from all claims for royalty infringements.

Two further stipulations for insertion in the conditional future contract are that before the execution of the contract Mr. Hirsch "shall deliver to the President and one member of the Board of Public Service full details of his process," and that the contract shall not be made until after these two members of the board "have verified the operating costs of the process so divulged."

The contract for the test plant, as authorized by ordinance on Aug. 14, provides that the plant shall be in operation within six weeks of the date funds to meet the contract become available.

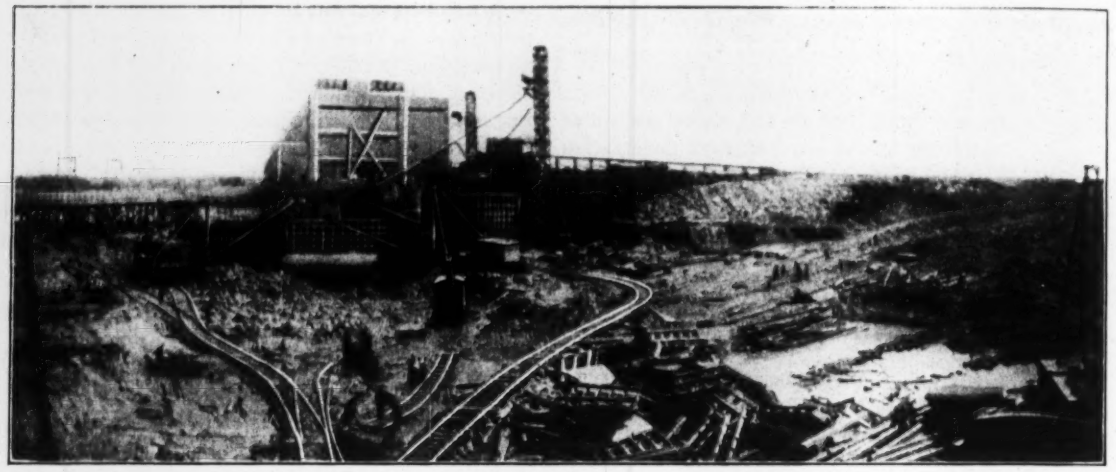
The president of the Board of Public Service of St. Louis, upon whom the contract here reviewed places much responsibility, is E. R. Kinsey. The Board of Public Service made a report to the Board of Aldermen on June 15, 1917, recommending that St. Louis build a garbage-reduction plant of the Cobwell type, at an estimated cost of $635,000, rather than buy the reduction plant of the Indiana Reduction Co., at Dupo, Ill., for $350,000 and spend $75,000 for improvements, or rather than build three incinerating plants at an estimated cost of $480,000.

Arrowrock Reservoir Cost Nearly $5,000,000

According to the Reclamation Service *Record* for August, 1917, the Arrowrock Reservoir on the Boise project of the United States Reclamation Service, cost $4,752,000, not including the power plant at the Boise River and the diversion dam.

Extension of St. Lawrence River Power Development Under Way

Substructure at Cedars Extended for Eight 10,800-Horsepower Units—New Superstructure Will House Three Exciters and Four Main Units, Only Two of Which Will Be Placed Now



CEDARS CANAL DEVELOPMENT EXTENDS ALONG ST. LAWRENCE RIVER

THE SECOND STEP in the 180,000-hp. hydroelectric development on the St. Lawrence River at Cedars Rapids, Quebec, is being made on account of the phenomenal demand for power on the system of the Montreal Light, Heat & Power Co., of which it is a part. The canal headrace is being enlarged to final dimensions and the dam is being completed to final length without interference to regular service.

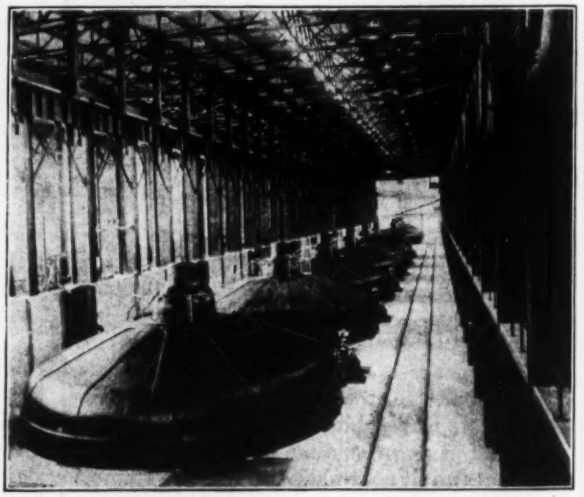
The first nine units of the plant went into service at the end of December, 1914. The tenth unit was in position shortly after. A heavy load was carried from the beginning of commercial operations, and this has steadily increased until at the present time this station apparently has the highest load factor of any on the continent, the percentage ratio of average to peak load being above 98%. With the ten 10,000-kv.-a. machines in service, 1,800,000 kw.-hr. is the daily output.

The accompanying sketch shows the general arrangement of the work both before and since the extension was started (for details of the design see *Engineering Record*, Oct. 25, 1913, and *Engineering News*, Mar. 25, and Apr. 1, 1915).

The dam across the end of the headrace canal, with which the turbine foundations are integral, is being completed for the ultimate development at this plant. There are now ten 10,800-hp. main units and three 1500-hp. exciters; there will be eventually 18 of the large units and six exciters. Only two more large units will be installed at the present time, the others to be added more leisurely as the demand for power may require.

The two main units to be installed at first will not lie next to the tenth already in place. Space is being prepared for three additional exciters in the line beyond these 12 large units, and still beyond the exciters will be the substructure for six more units, four places being temporarily unoccupied. The superstructure will be continued from the present No. 10 machine over the unoccupied bays and stop beyond No. 14, where a temporary housing will close the end. This superstructure will be of the same precast-unit concrete construction employed before (see *Engineering Record*, July 25, 1914, and *Engineering News*, Mar. 25, 1915).

This scheme of placing the new generating units permits of obtaining quicker service from them, since the existing cofferdam completing the temporary barrier at the end of the headrace canal blocks the intake of units 11 and 12. To use the turbine in places 13 and 14, however, it will be necessary only to cut through the crib enough to pass the flow for two units to the pool in front

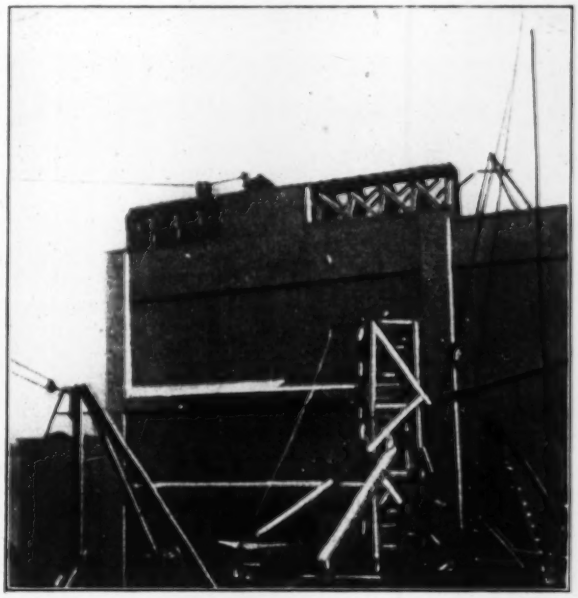


TURBINES IN CEDARS STATION HAVE RECORD DIMENSIONS

of the new part of the permanent dam. The rest of the old coffer can then be dredged out at leisure.

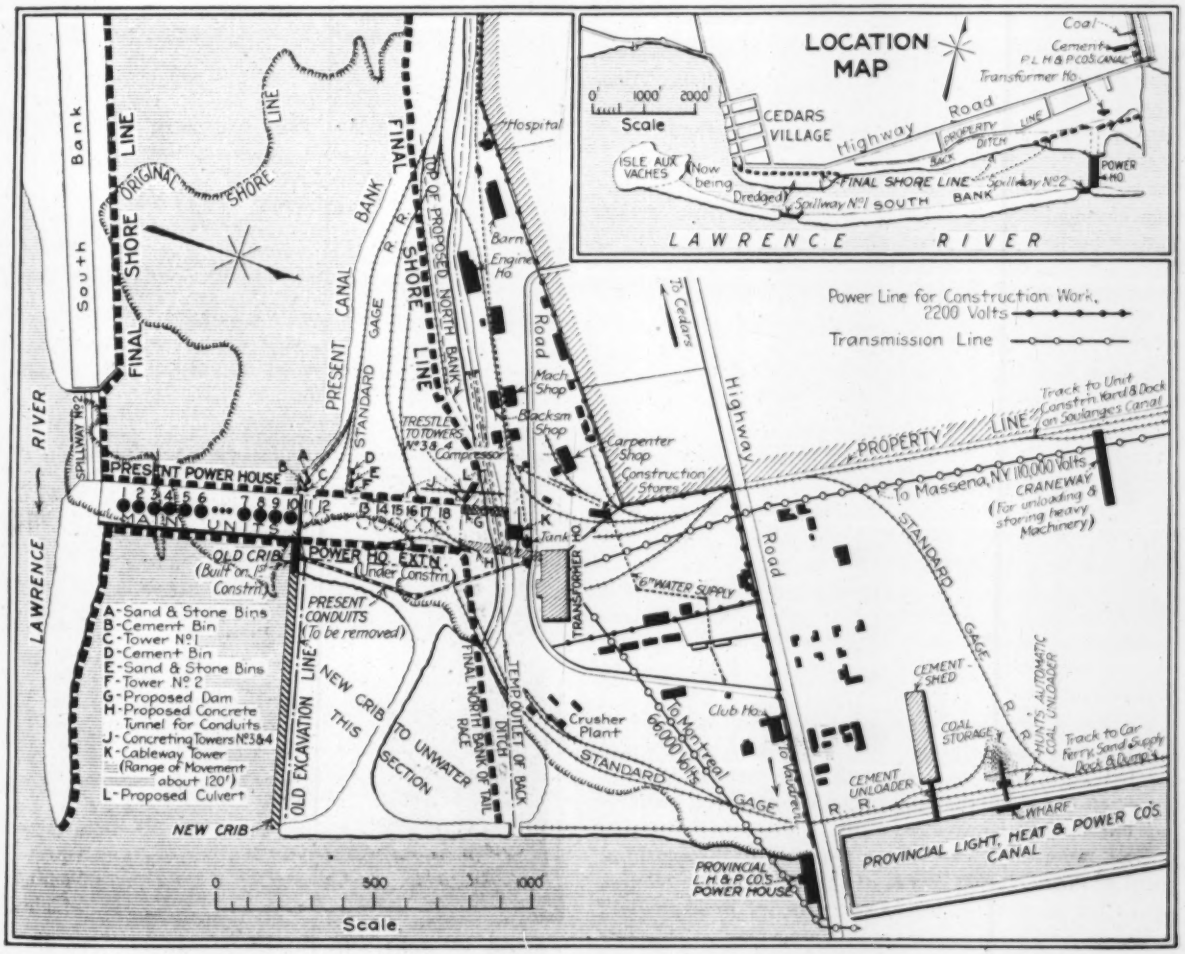
The most interesting novelty of the construction plant is the cableway for handling forms and materials for concrete, etc. This is shown in plan and in detail by the illustrations. The cableway is of a radial type and was built on the spot out of plant on hand—mostly left from the earlier Cedars construction. The total span of the cable from head frame to pivot is 1300 ft., but only 700 ft. is clear, for the cable passes along the roof of the existing power station and over an intermediate traveling support on the north end of the power house.

The head frame is a timber tower with its top 64 ft. above the track rails, built up of 8 x 16-in. timbers for the larger members and 8 x 10s and 8 x 8s for the others. The main cable is of plow-steel wire strands, and is 2¼ in. in diameter. For traversing the carriage a ¾-in. cable is used, and another is used for hoisting. The engines and one pair of trucks came off the Keokuk traveler used in placing concrete for the original work at Cedars. The other trucks were taken from railway cars. Traversing is done by a small hoist engine winding in on a cable which is run forward to anchorage. With a 120-ft. length of track, practically the whole width of the new work can be reached. The cableway does not handle concrete, as at each of the concreting towers is a mixing plant with stone, cement and sand bins, to which supplies are brought by cars running over construction tracks.

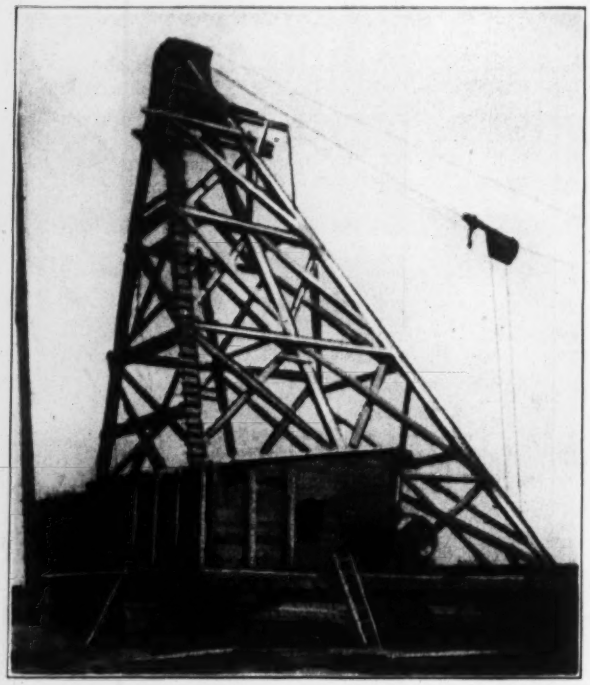


CABLEWAY HEAD TOWER WAS BUILT ON THE SPOT

A cofferdam is being built as shown for the unwatering of the tailrace site for the second development. This



GAP BETWEEN FIRST CEDARS DEVELOPMENT AND SHORE IS BEING CLOSED BY EXTENSION



CABLEWAY HAS A TRAVELING INTERMEDIATE SUPPORT

coffer is the extension of one built during the course of the first development, and left in place for protective purposes, and in such shape that the construction of the power-house extension could be started before the cofferdam for the complete tailrace excavation had been finished. This new coffer was built on the bottom of the tailrace of the first development, that earlier excavation having been made wide enough at the time of the first development to permit this.

It is hoped that unwatering the tailrace will cut off much of the water now entering the power-house excavation. The excavation for the north side of the tailrace cut through the stratification of the limestone rock and apparently left exposed a number of open seams through which the water is finding its way to the new excavation. When the tailrace is unwatered there will be no chance for the water to enter through these seams, and it is hoped that then the pumping will be no more for the power house and tailrace combined than was met with for the power-house work alone before the cofferdam was completed.

Some of the rock is being taken out with a steam shovel loading into side-dump cars, and some is hand-loaded into skips that are lifted to the dump cars by two stiffleg derricks which were moved as required to reach the spoil.

The canal bed above the station is being excavated in the dry by steam shovels. The work is in gravel and blasted rock, and is carried as close behind the old coffer as is considered safe. The old crib and remaining barrier will be dredged away.

Rock from the excavation is switched to the crushing plant at the northeast corner of the site, where a 36 x 42 Jenks jaw crusher serves as the primary breaker—and is the only addition to the old crushing plant. This jaw machine discharges upon a belt conveyor leading to a No. 7½ Traylor gyratory, and this in turn discharges to the screens. The rejections go to No. 5 gyratories.

The work is being done by the Civic Investment and Industrial Co., which operates the Montreal Light, Heat & Power Co., the Cedars Rapids Manufacturing & Power Co. and allied concerns. R. M. Wilson, of Montreal, is Chief Engineer. The immediate direction of the work is under G. P. Hawley, resident engineer. Fraser, Brace & Co., of Montreal and New York, are retained as supervising engineers. J. H. Brace is the firm's resident representative, and men from his organization are directly employed by the Civic company.

Road Types Often Condemned by Improper Maintenance

The Real Economy of Certain Specifications Lost Through Neglecting First Principles—Laymen Misunderstand

By B. H. Piepmeier

Maintenance Engineer, Illinois State Highway Department

MANY different types of roads have been condemned by the public chiefly on account of the lack of proper maintenance. The proper type of road may be selected by the engineer, but if he has no means of controlling maintenance his choice may be condemned by the average layman.

Public sentiment is molded largely by the results that are evident to the eye regardless of the money actually expended. It is not uncommon to hear the layman say that certain roads are very expensive and unsatisfactory. He often passes judgment upon a road and condemns it without any investigation of its cost or how economical and satisfactory it might be if properly maintained.

The average road engineer is confronted with the problem of educating the public to an appreciation of the principles of economy in road improvement as much as with technical matters, such as the selection of a type of pavement and the method of properly maintaining the roads after construction.

WELL GRADED AND DRAINED—BUT IMPASSABLE THROUGH NEGLECT OF SURFACE MAINTENANCE

A LITTLE ATTENTION TO CRACKS IN CONCRETE ROADS STOPS MUCH CRITICISM OF THIS EXCELLENT CONSTRUCTION.

There are three principal items of expense connected with road improvement which the engineer must impress upon the public mind before it will be possible for him to construct an economical system of roads. These factors are: The original cost of the improvement; the interest on the money invested in the improvement, and the total upkeep cost. When all of these factors are taken into consideration, it is evident that many of the cheaper types of roads, when properly maintained, will give the desired service and yet will be much more economical on account of their low first cost.

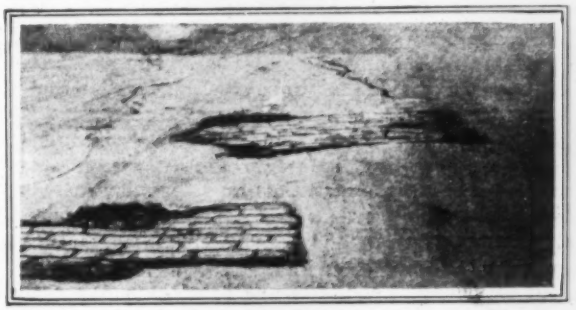
When a type of road is selected, taking into consideration the three principles set forth above, it is very essential that provision be made for proper and efficient maintenance. If local conditions are such that maintenance may be delayed or prevented, preference should be given to a type of pavement that requires only a small amount of maintenance and which will be serviceable for a period of time even with no maintenance. Neglecting proper maintenance for but one year on many types of roads is very much more serious than the amount of money involved represents. The road engineer should keep this in mind and thoroughly impress the fact upon the individuals who have a voice in the final determination of a type of road.

The tendency in road improvement is to select types of roads which require very little annual maintenance. The general feeling among laymen seems to be that when a road surface requires some annual maintenance to keep it in good shape, it is an expensive type and should be avoided. Yet, if the interest on investment and the repairs are taken into consideration, the cheaper wearing surface may in many cases prove to be the more satisfactory and economical.

It is not uncommon to see roads of a good type constructed and then, after they begin to show signs of wear, to see them neglected entirely or some method of repair or maintenance imposed which has been found by long practice to be defective. In most cases, it is true, such unsatisfactory maintenance work is directed by individuals over whom the engineer has no control. When we see mud holes in earth roads filled with riprap, crushed stone or cinders, it is not the engineer's fault that an enormous price is paid for the repair material; the road engineer knows that proper drainage, and repairing with earth from the side of the road, are the economical methods of maintenance.

Old gravel and macadam roads are often repaired by filling ruts and depressions with inferior material that is readily displaced by traffic or ground to dust. Bituminous surfaces are often patched, if patched at all, with loose stone or gravel, and in some cases with concrete. In a number of streets and roads recently inspected, brick was used to patch concrete surfaces, and concrete used to patch brick surfaces.

When careless methods of this kind are applied to the maintenance of public highways, the result is that a good type of road is made to appear unsatisfactory and



REPAIRS WITH BRICK GAVE ASPHALT A BAD NAME IN ONE COMMUNITY

uneconomical. Road improvement is discouraged—particularly the cheaper types of improvement, which in many localities are the best if properly maintained. It is the utter neglect of maintenance and the many improper methods of repair that have molded public sentiment against types of road requiring annual maintenance, and have led road promoters and officials to disregard many economical types. The city engineer and the highway engineer have a great field for educational work in presenting the fundamental facts of road economics.

Tannery Wastes' Anthrax Disinfection

Fine screening followed by disinfection with liquid chlorine at the rate of 50 p.p.m. proved a successful method of coping with anthrax germs in the wastes of an unnamed tannery, according to a paper by Prof. D. D. Jackson (Columbia University, New York City) and A. M. Buswell, reprinted from the *Journal* of the American Leather Chemists' Association for June, 1917. The topography made the construction of sedimentation tanks impracticable, so to remove suspended matter Riensch-Wurl screens 8 ft. in diameter with $\frac{1}{32}$ x 2-in. slots were installed to treat 500,000 gal. of tannery wastes a day. Chlorine was applied to the screened sewage by means of Wallace and Tiernan's regulating apparatus. During 14 months' operation no anthrax spores were found in the screened and disinfected wastes, although they were found six times in the untreated wastes. The screens removed about 6 bbl. daily of hair, hide and fleshings, which material was shipped to a fertilizer plant and disinfected by steam. The paper mentioned gives a historical review of pertinent information on anthrax, besides a detailed account of laboratory and large-scale disinfection tests.

Trend of Thought in the Water-Works Field

Abstracts of Presidential Address and Some of the Technical Papers Presented at the Thirty-Sixth Annual Convention of the New England Water-Works Association at Hartford, Conn., Sept. 11-15.

Today's Problems in Water-Works Management

By Caleb Mills Saville

President, New England Water-Works Association and Chief Engineer, Water Department, Hartford, Conn.

TODAY something more is required of the water-works executive than to be able to get 480 minutes' work for the price of labor, properly to lay pipe and quickly to repair a break in a supply main. These things are necessary in carrying on department work, but they are not the essentials of present-day management. The water-works executive must be familiar with all of these, but in addition he must have intimate knowledge of and ability to handle such financial questions as valuation of works and equitable rate-making, as well as hydraulic problems relating to supply and construction or the complex questions involved in providing a water which satisfies modern standards.

Intelligent systems of accounting are necessary. Rules and regulations adjusted to present conditions are required. Scientific purchase of materials and supplies, cost-keeping that instructs, modern transportation, checks on the care of department property and similar matters are all part of the organization of even the mediocre construction company. How can water department business succeed without them?

Rate Revision Urgent

The question of revision of rates to meet existing conditions is most vital to successful operation, but one which is often the last to be taken up, particularly in municipally-operated plants. Many rate schedules now in use even in our larger cities are inheritances of the past, continued because of the inertia of the present. Some of these are ridiculously inadequate and fail utterly to recognize conditions of plant, cost of operation, and special value to different classes of users. Such conditions result in extravagant operation and in ineffectual service.

At the present time it is the trend of opinion, based on judgment of the best sanitary specialists, that all public water supplies sooner or later must be filtered. Water is demanded which is clean and attractive, as well as safe. These questions involve protection from pollution, removal of turbidity and color, reduction of chemical constituents producing hardness and other detrimental conditions, and the elimination of taste and odor.

These are some of the problems of the modern water-works executive. Properly met, they mean efficiency in organization and economy in operation, with consequent benefit to the city. To do these things it is necessary that the manager of the water department shall be able to grasp, understand and control adverse conditions which were formerly accepted as inevitable but are now known to be amenable to remedy if not to cure.

No Water-Works Alliance

The past experience of this association, with its avoidance of entangling alliances, in the best guide we can have for the future. Our present position as a power in water department matters shows clearly the wisdom of the founders of this association in rigidly excluding both politics and commercial exploitation from its voting membership. "As with the Fathers so may God be with us." With other organizations we will work together gladly and we welcome all water-works men to our membership. Careful consideration of our own particular needs and purposes, however, forbids any thought of combination with others.

In these critical and serious times it is well for us to cultivate the attitude of the open mind and the spirit of coöperation. One of the most cogent reasons why our manufactured products, up to the war period, had so little market in Central and South America was the arbitrary stand of American producers as to details of construction and methods of packing goods, regardless of the needs of the purchaser.

Until many of our manufacturers and consumers, on the one hand, emerge from this attitude of pigheadedness, and, on the other, step aside from a position of cocksureness, there will be difficulty in meeting the demands of commercial enterprise and construction possibility. Opportunity is hindered by ignorance and the effect of the small mind unable to comprehend the standpoint of the other fellow. The talisman of success in coöperation. Manufacturers must concede the necessity and be willing to consider with open mind changes in plant, even though expensive to them, if efficiency and economy result in construction work.

Engineers and users of manufactured products must recognize business exigencies and matters affecting established industry. They too, must have the open mind which is free from personal bias, broad in its outlook and dispossessed of a finicky attitude. In the "get-together" atmosphere of this convention let us all try to get into touch with the real reasons for the differences between users and producers and see if we cannot reach some mutually advantageous ground in advance of that on which we now stand.

The Trend of Prices

In these days the direction of the force of gravity as regards cost of labor and materials appears to have been reversed. An efficient way and perhaps the best way to meet this condition seems now to be the more general use of labor-saving tools, careful selection of materials,

more thoughtful planning of work and better organization of force. Present prices of labor and materials in many cases are beyond that ever before experienced, and the outlook seems to reveal little or no downward tendency. For a short period there seemed to be a faltering in construction work but contract news, construction advertisements, and bond sales indicate recovery with a tendency to accept present prices as better perhaps than will be afforded latter. From this viewpoint, more and more public work of considerable magnitude is being let. With the reduction of labor due to national requirements and the possibility of greater demands for materials, even if peace should come quickly there seems to be greater chance for increasing cost of work for sometime to come.

Meters Cut Waste in Metropolitan Water District

By Samuel E. Killam

Superintendent Pipe Lines and Reservoirs, Metropolitan Water-Works, Boston.

In 1902, the Massachusetts legislature authorized the Metropolitan Water and Sewerage Board to construct works for the measurement of water supplied to the cities and towns in the Metropolitan Water District and to report the quantity supplied to each and also whether the water was being improperly or unnecessarily used and to make recommendations in regard to preventing waste and the manner of proportioning the annual water assessment.

The Venturi meter was adopted as the best and most suitable device to measure the large quantities required without too great a loss of head. There are now 69 meter tubes installed in the district, varying in size from 6 to 60 in. In districts where the quantity to be measured is small the Hersey detector meter has been used.

The total cost to Jan. 1, 1917, of installing the meters, including meter registers and appurtenances, was $94,364. The total cost for charts and repairs to meter registers since their installation in 1903 averaged about $3.50 per meter register per year.

Leading Up to Universal Meter System

In 1907 an act was passed which provided that after Jan. 1, 1908, all cities and towns which derived their source of supply from the Metropolitan Water-Works should equip all new service pipes with water meters and should also equip annually with meters 5% of the services that were unmetered on Dec. 31, 1907, and should thereafter charge each consumer in proportion to the amount of water used.

The quantity of water consumed became a very important element and it was made an incentive, not only for the district as a whole, but for each municipality, and finally, the most important of all, each consumer, to check and to stop the unnecessary and wasteful consumption of water.

The gradual installation of more service meters in the district has reduced the average daily consumption per inhabitant from 130 gal. in 1907 to 89 gal. in 1916. Meter, consumption and related figures for each city and town in the district are given in the accompanying table.

There has been a gradual reduction in the quantity of water used with the increase in the use of meters. In Melrose, which is largely residential, the reduction due to the installation of service meters was especially noticeable. The introduction of meters was begun in 1907. On Jan. 1, 1908, about 30% of the takers were changed from scheduled to meter rates and at the end of the year 1908 practically all the services were metered. The records on the master meter showed a saving of 55 gal. per capita in two years, a reduction of 46.7%, or from 117 to 62 gal. In 1916 the consumption went down to 45 gal.

Night Consumption Still Too High

Turning now to the district as a whole, the fact that between the hours of 1 and 4 a.m., when the legitimate use of water is at its minimum, water is drawn from the mains in the district at the rate of over 60,900,000 gal. in 24 hours, equivalent to 51 gal. per capita, is very strong proof that, notwithstanding the decrease in the consumption, a large amount of preventable waste is still taking place.

Notwithstanding an increase of over 350,000 in the number of people supplied in the whole district the average daily consumption was less in 1916 than it was in 1899, 17 years ago. The per capita consumption was the same in 1916 as in 1894.

The daily average quantity of water used in the district in 1916 was 17,808,000 gal. less than during the year 1908, and the per capita consumption has been reduced from 130 gal. to 89 gal., equivalent to over 31%. This reduction in the use of water has been accom-

REDUCTION OF WATER CONSUMPTION BY USE OF METERS IN METROPOLITAN WATER DISTRICT, MASSACHUSETTS, 1907 TO 1916

City or Town	Area Square Miles	Estimated Population July 1, 1916	Services in Use Jan. 1, 1916	Meters in Use Jan. 1, 1916	Miles of Pipes Jan. 1, 1916	Per Cent. of Services Metered Jan. 1, 1907	Per Cent. of Services Metered Jan. 1, 1916	Consumption per Capita 1 A.M. to 4 A.M. 1907	Consumption per Capita 1 A.M. to 4 A.M. 1916	Consumption per Capita Average Daily 1907	Consumption per Capita Average Daily 1916
Arlington	5.2	15,670	2,753	2,755	45.10	33.6	100.0	50	28	91	59
Belmont	4.6	8,560	1,430	1,430	29.38	100.0	100.0	31	18	68	52
Boston	42.8	762,700	103,195	54,848	849.35	5.5	53.2	107	62	153	105
Chelsea	2.3	45,020	4,971	4,957	43.30	14.6	99.7	59	35	97	68
Everett	3.4	38,870	6,893	8,947	50.21	2.0	50.0	50	42	82	74
Lexington	16.0	5,660	1,156	1,063	36.32	2.1	92.0	43	37	69	69
Malden	4.9	50,160	8,055	7,696	90.18	93.6	95.5	22	28	46	49
Medford	7.1	32,080	6,043	5,846	67.19	10.5	100.0	65	22	102	46
Melrose	5.1	17,260	4,005	4,211	52.99	3.9	100.0	85	26	117	45
Milton	12.9	8,850	1,867	1,926	50.06	100.0	100.0	16	10	46	42
Nahant	1.0	1,440	730	468	22.07	17.2	64.1	50	51	130	110
Quincy	16.5	42,030	9,315	8,248	129.74	14.2	88.6	66	39	100	59
Revere	5.9	26,790	4,413	3,125	52.99	4.8	70.8	54	34	82	59
Somerville	4.2	89,190	13,233	9,155	95.42	24.6	69.2	55	34	90	69
Stoneham	6.6	7,590	1,613	1,589	26.13	1.9	98.5	55	29	91	58
Swampscott	3.1	7,580	1,810	1,810	21.99	37.8	100.0	41	28	85	59
Watertown	4.1	17,280	2,798	2,622	38.20	98.3	100.0	36	29	67	65
Winthrop	1.6	13,470	2,903	2,829	32.23	2.3	100.0	65	26	105	53
District	147.3	1,190,220	176,183	117,525	1,732.85	14.7	66.8	83	51	130	89

plished largely by the introduction of service meters. If the conditions as they existed prior to 1904 had been allowed to continue additional sources of supply would, without doubt, have been required before the present time. It is also probable that if the act requiring the installation of service meters on all works receiving a supply from the Metropolitan works had not been enacted it would have been necessary to construct additional works by 1920.

Best To Sell All Water by Meter

Many are willing to pay for their own and their neighbors waste by general taxation but are unwilling to continue to pay for their own waste when presented with a quarterly bill.

The writer believes that water meters are as much a part of a well operated water-works system as gas or electric meters are to their respective works. Many gas companies account for 80% of gas delivered through the master meters. Well managed water-works in Europe account for all but 10% of their supply. Cannot American municipalities do as well?

Waste of water can be divided into two classes, leakage from mains and waste from service pipes. The first can be stopped by efficient management and the latter by enlisting the consumer's coöperation by giving him a direct pecuniary benefit. It appears to the writer that the best way to get results is to sell the water by measure and to keep the measuring devices in good working condition.

Rapid Sand Filtration Holds World Record

By George A. Johnson
Consulting Engineer, New York City

RAPID sand filtration, was first applied in the treatment of municipal water-supplies at Somerville, N. J., in 1885. Up to that time it had been used only in the purification of waters for industrial uses, while slow sand filtration had already gained an accredited standing abroad as a potent aid in the reduction of water-borne diseases. In 1885 a few small slow sand filter plants had been built in this country, the first of those being at Poughkeepsie, N. Y., in 1874.

From its very inception rapid filtration established its popularity over all other hitherto attempted methods of purifying water. It has steadfastly held that position throughout the 32 years which have since elapsed.

Of the 18,293,000 people now supplied with filtered water in the United States 74%, or 13,411,000, are supplied from 682 rapid sand filter plants, the remaining 26% or 4,882,000 people, being served from 54 slow sand filter plants. In Canada there are now some 45 municipal filter plants supplying a total of about 1,500,000 people, or about one in every six of the total population. Thirty-nine of these plants are rapid sand filters serving about 1,000,000 people. In foreign countries there are some 81 municipal rapid sand filter plants with a total daily filtering capacity of about 175,000,000 U. S. gal., serving about 3,500,000 people.

Since 1910 the progress in municipal water filtration in the United States has been noteworthy. The population supplied with filtered water has increased 69% and the total capacity of the filter plants in operation has increased 81%. The increase in rapid sand filtration has been particularly marked in the last six years, the population served by filters of this type having increased by 94%, as compared with an increase of 26% for slow sand filters. The daily filtering capacity of slow sand filter plants has increased by 11% since 1910, whereas the capacity of rapid sand filter plants has shown an increase of 139%. This is explainable by the fact that the increase in the slow sand filter population is accounted for chiefly by the natural increase in population in cities which already had filter plants in 1910, but few new slow sand filter plants having been built since that time.

The increase in rapid sand filter population since 1910, however, was principally due to the construction of new filter plants, as for example those built at Akron, Ohio; Baltimore, Md.; Dallas, Tex.; Erie, Penn.; Grand Rapids, Mich.; Minneapolis, Minn.; St. Louis, Mo. and Trenton, N. J. These eight plants alone provide a filtering capacity of 462,000,000 gal. daily and serve a total present population of 2,400,000.

Since 1910 the most notable additions to the slow sand filters then in operation were the plants at Brookline and Lowell, Mass., and the Queen Lane plant at Philadelphia. The two Massachusetts plants were built especially with iron and manganese removal in view.

Modified Use of Slow Sand Filters

A noteworthy feature in connection with slow sand filtration practice in America refers to alterations in the layouts as originally designed for several large cities, and the adoption of either prefiltration or coagulation, or both, in the pretreatment of the water before final filtration through the slow sand filters. Thus at Albany coagulating basins and preliminary roughing filters have been added to the original slow sand filter plant to lessen the load on the final filters and permit them to do satisfactory work. For the same reason preliminary filters were added to the Pittsburgh plant two years after the original plant went into operation. Philadelphia has adopted coagulation of the raw water at four out of five plants, and at Washington and Poughkeepsie coagulation of the raw water now forms a part of the preparatory treatment.

Of the 40 cities wherein the slow sand filters are operated as such without radical modifications, those of Denver, New Haven, Yonkers, Reading, Providence and Philadelphia (Upper Roxborough) are the largest, and have a combined daily capacity of 124,000,000 gal. The remaining 35 plants are small, averaging a daily capacity of 2,000,000 gal.

Of the 54 cities having slow sand filter plants now in service in the United States with a total daily filtering capacity of 922,000,000 gal., 40 provide no pretreatment other than plain sedimentation in impounding reservoirs or settling basins. The plants in these 40 cities have a total rated daily capacity of 196,000,000 gal. or an average of 4,900,000 gal. daily.

The remaining 14 cities have slow sand plants with a total filtering capacity rated at 726,000,000 gal. In five of these cities slow sand filtration is preceded by prefiltration at high rate; in four cities by coagulation and prefiltration; in one city (Philadelphia) by coagu-

lation and prefiltration at four plants; and in the remaining five cities by coagulation and sedimentation.

[The foregoing notes have been condensed from the opening pages of an exhaustive paper on "Rapid Sand Filtration" read, in part, by Mr. Johnson at the Hartford convention.—Editor]

Mechanical Filter Bottoms and Strainer Systems

By Robert Spurr Weston
Consulting Engineer, Boston, Mass.

IT IS unnecessary to recall to your minds that the strainer system of the mechanical filter, unlike that of a sand filter, serves two purposes; namely, it must collect filtered water from the sand and must serve as a distributing medium for the wash water used for washing. Unfortunately, the velocity during washing may be more than five times the velocity during filtration, and this, of course, introduces great difficulties in design; for it is essential that the rate of filtration be uniform throughout the whole sand layer, and that the wash water be distributed as uniformly as practicable over the whole filter area so that it may rise as a plane or sheet for the purpose of separating the accumulated coagulant and fine suspended matter without at the same time causing any considerable loss of sand.

Four Strainer Systems Reviewed

The most generally satisfactory strainer systems are: (1) Manifolds, strainers and a 14-in. layer of gravel. (2) The Harrisburg system of perforated pipes with a 14-in. layer of gravel. (3) Troughs having strainers at their bottoms, with a 14-in. layer of gravel. (4) The Wheeler filter bottom with 8 in. of gravel.

All of these systems should be designed to wash the sand layer without the use of air. Each system has its advantages and disadvantages, but the excessive cost of system No. 3 makes its use inadvisable. There are, therefore, three systems left. Of these, system No. 2, the Harrisburg system, is the simplest. It, however, consists largely of metal, all of which is exposed, and at the present prices is probably more expensive than the Wheeler filter bottom. System No. 1, like that installed by most of the filter companies, possesses the advantage over System No. 2, the Harrisburg system, of having the outsides of the pipes protected by concrete. The strainers, however, are exposed and must be constructed of bronze, which at present prices makes the installation costly, probably the highest of the three. The insides of the pipes are likewise exposed.

In either of the above systems there exist "dead" spaces on the floor of the filter between the openings where the wash water does not readily reach. This difficulty is overcome in Systems Nos. 3 and 4, of which No. 4, the Wheeler filter bottom, is the cheaper. The advantages of the Wheeler filter bottom consist in the absence of metal (with the exception of the short brass tube at the apex of the pyramid); the nearly perfect distribution of the wash water secured by the "ball nozzle" effect of the balls; the lower cost, and the thinner gravel layer. The writer of these notes believes that the Wheeler filter bottom is best when placed above channels rather than built as a false bottom of the filter, although to construct the latter is perfectly feasible.

Why Sand Broke Through Gravel at Akron

Considerable difficulty has been experienced with the Wheeler filter bottom at Akron because of sand passing through the gravel around the walls of the filter, particularly at the corners. The writer has investigated this filter and found that there was a ledge 1 in. wide left around the walls of the filter and furthermore the gravel layer was only 6 in. in depth. It was very difficult for the workmen to spread 1.5-in. layers of gravel evenly in the large units (2,000,000 gal. daily); consequently the sand had passed through the gravel in certain places until it rested on the ledge around the walls of the filter. This sand remained inactive. The difficulty was overcome by increasing the thickness of the gravel layer around the walls of the filter, particularly at the corners. Less than 0.5% of the area of the filter was involved. This is a very low percentage of sand surface out of action because of lumps, hard spots, etc., and the difficulty can be readily overcome. It would probably be best in a new filter with this bottom to make the gravel layer 8 in. in thickness; namely, 4 in. coarse gravel, 2 in. medium gravel and 2 in. fine gravel, rather than 3, 1½ and 1½ in., respectively, first used. Where the filter area is small, the thicknesses of the gravel layer may be reduced to those last given.

In large filters there seems to be a tendency toward wave motion in the underdrains, which may accumulate pressure at certain points in the filter bed, particularly at the ends of the channels, and may possibly cause the rupture of the gravel layer if it be too thin. This statement of course applies equally well to the three systems under consideration. The Wheeler filter bottom is better designed to resist jet action from the strainers than are either of the others. The effect of a large ball immediately above the orifice is absolute and unchangeable.

False Bottom of Strainer Manifold Type?

The discussion regarding choice of filter bottoms at present centers around the relative merits of the false bottom and the strainer or manifold type. The false bottom was used in the Miraflores (C. Z.), Erie and other plants, but only a few plants have been so built. The fear in the minds of operators of filter plants is that they may not prove so efficient bacteriologically as a plant designed on the other plan. On the other hand, the false bottom approaches nearer the condition for successful washing—namely, that of a series of orifices discharging from a tank—but with underdrain channels of sufficient size, relative to the areas of the orifices discharging, from them, good enough distribution may be secured for all practical purposes, and the dangers, both structural and in operation, which the false bottom presents, avoided. There should be no objection to the use of the false bottom in small filters.

Should Wash at High Velocity with Water Only

Thirty years' experience and the results of experiments by Ellms and others, indicate that the successful filter will be washed at a high velocity with water alone

This effect is best secured by a strainer system consisting of orifices, above each of which is placed a layer of graded material to prevent sand from passing out of the filter, either when filtering or washing.

The underdrain system should be designed to throttle the discharge of wash water from the orifices. The latter should be reasonably large to avoid unusual loss of head in the filter, and the underdrains should be proportioned to the orifices. The false bottom system, while cheaper, is not so reliable as the other systems, and there are more or less troublesome results from cast- or wrought-iron headers and manifold-strainer systems, even when they are cheaper, which is rarely the case. The Wheeler bottom, with sufficient gravel, best fulfills the conditions of practice. It is, however, on account of its being a patented device, more expensive than the Harrisburg system. On the other hand, it is more durable.

Leadite Joints Saved $2800 on Single Contract

By Homer R. Turner
Superintendent and Engineer Fire District, Windsor, Conn.

IN DRAWING up proposals for 28,000 ft. of 10-in. cast-iron water mains alternative prices were asked on lead and Leadite joints. The contractor to whom the work was awarded, offered to do the work with Leadite joints for 10c. per foot less than with lead joints. After favorable replies were received from several users of Leadite we determined to use the material.

Leadite comes in the form of a black powder put up in 100-lb. bags. We used an ordinary portable furnace burning coke, controlling the temperature by dampening the fire with soil when necessary. One attendant is kept on this furnace continually as the material requires constant stirring and proper control of the temperature to prevent burning. The Leadite is melted until it is of the consistency of medium oil and the appearance of the surface of the liquid is smooth and free from bubbles. At this stage it has a mirrorlike surface and is ready to pour. The temperature at this time is very slightly above the melting point and a higher temperature will cause bubbles to appear. Any increase in temperature will cause the material to thicken until it becomes stringy. If this occurs the pot should be removed from the fire and cooled until the temperature is reduced so that the material is of the proper consistency.

Pouring the Joints

Dry jute should be used in the joints as the presence of oil or grease from tarred jute prevents a good bond between the Leadite and the cast-iron pipe. The material is poured similarly to lead, it being necessary, however, to build the gate at least 3 in. above the top of the bell. This is required as the material is too light to flow back into the joint at the top of the bell of the pipe without a slight head to force it. Joints made up with an ordinary gate, such as is used for lead, proved to be imperfect as the material did not properly fill the joint at the top. The Leadite in the gate can be broken from the joint when cold and remelted after being properly cleaned.

We obtained better results with the joints when the pouring was kept back at least four lengths of pipe from the laying gang. The shock of driving home a new length of pipe tends to break a freshly made joint.

One serious disadvantage in the use of the material is its tendency to crack, it being brittle on new work. One 6-in. pipe crossing laid under a railroad track in 1914 has broken down at the joints and it has been necessary to cut-out the Leadite and use lead in this location. Another disadvantage of Leadite is that in repairing a defective Leadite joint it is necessary to shut the water off the main. It has been found impossible to caulk or patch a Leadite joint with lead wool or other material. Best results are obtained by entirely removing the Leadite from the joint and either repouring the joint with Leadite or lead. On the other hand the ease with which plugs can be cut out or joints cut away in order to remove several lengths of pipe has proven of distinct advantage.

Tests of Leadite Joints

As the standpipe was not completed when the pipe lines were laid we were forced to omit exact tests of joints after pouring but each joint was inspected when a section was filled with water before back filling was done. Final tests were made this year.

The only method available in making these tests was to shut off each service connection at the curb cock and to shut off all gates on adjacent lines. No doubt some of the water measured as leakage was lost through leaky services or gates but the results have been figured on the assumption that the total loss of water was through the Leadite joints only. The standpipe was pumped full of water to give the maximum available pressure on the lines to be tested. The pressures on 35% of the line tested ranged from 45 to 70 lb. and on 65% from 70 to 98 lb. per square inch. The duration of the test was four hours. The actual quantity of water registered through the meter was 39.4 cu.ft. or 1773 gal. per 24 hours. Correction for under-registration of the meter gave a total loss of water from leakage of 1861 gal. per 24 hours or 0.36 gal. per 24 hours per lin.ft. of joint.

Better Sanitary Service for Springfield

Among improvements in the health and sanitary service of Springfield, Ohio, recommended by Dr. Carroll Fox, surgeon United States Public Health Service (Public Health Reports, Aug. 10, 1917, Washington, D. C.) after a two months' study on the ground, are the following:

That a full-time bacteriologist be employed at not less than $1000 a year.

That daily bacteriological examinations be made in the laboratory of the health department of the city water-supply.

That the city install as soon as practicable a modern disposal plant for the treatment of sewage, a chlorine plant for the treatment of the water-supply, a municipal abattoir and an incinerator for the disposal of garbage.

That thorough and comprehensive study be made looking toward the development of a satisfactory water-supply for the city.

That the plumbing inspector be transferred to a building division or the engineering department.

Building Army City in Wilderness Was the Problem at Camp Pike

Site for Arkansas Cantonment Was 5 Miles from Nearest Railroad—Much Clearing and Rock Excavation Necessary—Standard Two-Story Barracks for 200 Men Built in Less Than 3 Hours

GROUND was officially broken for Camp Pike, Arkansas, one of the sixteen National Army cantonments, on July 9, but the nearest railroad on that date was 5 miles away, and the only supplies obtainable were at Little Rock, 8 miles distant. All material and all labor, therefore, had to be hauled by wagon or truck up the hilly roads leading from the city to the reservation. During those weeks work was practically at a standstill, and it was not until July 16 that the hurriedly constructed tracks of the Missouri Pacific, requiring a large amount of rock excavation, crossed the line of the reservation. The building of the 12th Division Cantonment then really began. Contrary to the general rule of selecting level areas for cantonments, Camp Pike is situated on a hill, or series of small hills, and is full of steep grades. Almost every foot of the land had to be cleared of a comparatively heavy second growth of forest. The sewer excavation averages 75% rock. Added to this, the remoteness from a railroad and from electric light and water supply, and the many difficulties in obtaining labor, have presented numerous problems that had to be solved and solved quickly by James Stewart & Co. Inc., the contractors.

Unload Million Feet of Lumber Daily

In the preliminary stages what little material could be obtained came from the lumber yards of Little Rock, until gradually a more adequate supply began to flow in from the mills of Arkansas. This supply grew steadily until for weeks the average amount of lumber unloaded at the camp has been a million feet a day and that has lately been increased to one and one-half millions daily. Night shifts take up the work of unloading when the day gangs stop and work under powerful searchlights, helping to unload the more than 100 cars that come in every day. The cantonment, when completed, will consist of over 1600 buildings and over 32,000,000 ft. of lumber will be used in their construction.

Of the more than 1600 buildings that comprise the cantonment, over 200 are the two-story barracks, 43 by 140 ft. built to house 200 soldiers, with cots upstairs and mess halls and kitchens on the first floor. The buildings are equipped with electric lights, toilets, shower baths, water and sewer connections. On Sept. 1 enough buildings were completed to house 5000 Arkansas troops, and new companies are moving in every few days. Other barracks are used temporarily by the contractors as offices, mess houses, etc., for their men. Work on the officers' quarters has kept pace with the barracks, and steam fitters are putting the finishing touches in these. All officers' quarters will be supplied with steam heat—an innovation in cantonment building in the Southwest—and 1763 radiators and over 8 miles of piping will be required for the work. Each building will be heated by the low-pressure gravity system, with a separate cast-iron boiler for each building. The method of piping is unique from the fact that each radiator is a part of the main, which is 20-in. piping, connected straight through the radiator, the latter being suspended from the wall by brackets.

Another big part of the building construction included the ten huge storehouses for the division quartermasters, the base hospital and the remount station. The latter, which is located 2 miles from the main part of the camp, will consist of 120 buildings, mainly stables, but including barracks, mess houses, officers' quarters and administration buildings, a blacksmith school and hospital stables. Some of the buildings in this unit are 380 ft. in length. The entire station, consisting of 160 acres and planned to hold 10,000 horses, will be

HOW CONSTRUCTION AT CAMP PIKE HAD PROGRESSED UP TO AUGUST 22, ONLY A LITTLE MORE THAN A MONTH AFTER WORK HAD BEEN ACTIVELY UNDER WAY

inclosed with 20,000 ft. of woven-mesh wire, 58 in. high, with a rail 1 ft. above. The base hospital contains 1000 beds. This unit alone, which consists of 75 buildings and extends over 47 acres, will use up at least 3,000,000 ft. of lumber. It will have its own heating plant and laundry, and quarters are being built to accommodate 40 medical officers, 200 enlisted men and 65 trained nurses. Eight carloads of beds, apparatus, etc., have already arrived as a part of the hospital equipment.

Build Barracks in 3 Hours

In building construction a specially remarkable record was recently made at Camp Pike when a two-story barracks, 43 by 140 ft., was erected in 2 hours and 55 min. Work was begun at 9 a.m. and at 11: 55 a.m. the building was enclosed, floor laid, stairs in place, doors hung and windows fitted in and even screened, all scaffolding had been removed and the workmen had left the building. The amount of lumber required for this barracks is 60,000 ft. Two hundred carpenters were simultaneously employed on the work, and a remarkable feature of the construction was that, in spite of the number of workmen and the high speed at which the work was rushed, not a man received a scratch or bruise.

The schedule of completion was as follows: 9 a.m.—Work started; 9: 20—posts and studding up for first story; 9: 22—joists started for second floor; 10—second floor outside frame started; 10: 20—second floor outside frame finished, first story trim and mill work finished; 10: 45—joists on second floor finished; 11—flooring on second floor finished; 11: 05—rafters started on roof; 11: 30—rafters finished; 11: 50—roofing finished, second story trim and mill work finished; 11: 55 scaffolding down and workmen out. As the work progressed moving pictures were taken by Government photographers for purposes of record.

All this, of course, was a little out of the ordinary, but the fact that while this particular barracks was going up thousands of other workmen were busy on at least 200 other buildings throughout the cantonment, gives some idea of the rapidity with which the work proceeds. The record above is quite often closely approached in the daily routine of ordinary work. Only a few days ago the company's commissary chief received word late in the afternoon that a new mess house, to feed 200 men, must be opened at once at the remount station, where work was just beginning. He rode out and found that the ground was just being cleared for the building, a one-story structure 133 ft. long. The lumber was piled up near by, but not a stick had been touched. He explained his needs to the foreman, and the next morning sent out truck-load after truck-load of cooking utensils, crockery, food, etc. That evening supper was served in the building.

Solving the Water-Supply Problem

One of the first big problems that confronted the contractors was that of a safe and adequate water-supply. When ground was broken, Camp Pike was 8 miles from water mains, 500 ft. above sea level, and without any natural sources of supply. Work upon a temporary system was rushed. Within a week wells had been driven, and within ten days tanks were up and in use. Since that time an ample supply has been furnished the camp for its daily increasing needs, its thousands of workmen and its herds of horses and mules.

In the meantime, work has steadily progressed on the permanent system; in fact, the trenching and pipelaying for the temporary system have been done, wherever possible, as a part of the permanent system. When the latter is completed, artesian water for the cantonment will be supplied by the Arkansas Water Company, of Little Rock. From Argenta, near Little Rock on the cantonment side, a 16-in. main has been laid to a point near Levee, about 2 miles from the reservation, where a booster station has been erected with a 200,000-gal. tank, into which water will be forced by city pressure. Thence it will be pumped by three Platt Iron Works three-stage centrifugal pumps, operated by belt-driven 100-hp. motors. Each pump has a capacity of 750 gal. per minute and operates under 300-ft. head. A 16-in. Remco redwood pipe will carry the water from the station to the cantonment. Here it will be received in five 200,000-gal. tanks, whence it will be pumped

throughout the cantonment by four direct-connected Allis-Chalmers motor-driven pumps, operating under 100-ft. head. Two of the motors are 50 hp. and two 75 hp. The water system is laid out along the lines of the streets and roads of the camp, with laterals to the various buildings, and is equipped with hydrants at about every 300 ft. for fire protection.

Altogether, the system will include 7 miles of 16-in. main pipe and 20 miles of 6-, 8-, 10- and 12-in. redwood and cast-iron mains, and about 25 miles of smaller lateral metal pipe. It is estimated that on Sept. 1 work on the original contract was at least 75% completed. When finished, a daily supply of 2,225,000 gal. of water will be furnished the camp, entirely adequate for the 40,000 soldiers and 10,000 horses and mules to be quartered there.

The Sewer System

The sewer system of the camp consists of a septic tank three main trunks, with a total length of about 6 miles, and about 14 miles of laterals. Work on this branch of construction has been peculiarly difficult, and has taxed the resources of the contractor to the utmost. The material excavated in digging trenches averages at least three-quarters rock—shale, slate and trap—and in several places the cuts run as deep as 23 ft. Four sewer-excavating machines, one Parsons, one Keystone of the drag-line type, one Austin caterpillar and one Buckeye, are used constantly, but are frequently delayed on account of the vast amount of rock, which requires constant blasting. The work progresses steadily, however, the machines working at night under searchlights, and the men with picks and shovels beneath strings of traveling incandescents, which move along as the trenches extend. The septic tank, half a mile from the nearest barracks, is nearly completed. This is 50 x 100 ft. in size and divided into eight compartments with walls 10-ft. high.

Plumbing, Electric Light and Power

Of the 1600 buildings of the cantonment plumbing is required in nearly half. Between 300 and 400 plumbers are constantly employed, and have practically finished the work of roughing in. The installation of fixtures and finishing showers is well under way. All of the 400 lavatories have concrete floors and foundations, and nearly a million feet of lumber was used in the forms for these, mainly on account of the unevenness of the ground. While among the least spectacular of the various branches of construction, probably no other line better illustrates the advanced stage of the work at Camp Pike than this department. On account of the great variety of operations, the amount of detail involved and the number of different kinds of mechanics employed at various stages of the work, the department is peculiarly difficult to organize and keep up with the general progress of construction, but the contractors have succeeded in doing this to a remarkable degree and have fulfilled all expectations.

The Labor Supply

From the very beginning, the supply of labor at Camp Pike has been scarce and, largely of an inferior quality. Government work at Fort Riley and Louisville, which had been started in the latter part of June, with railroad tracks running alongside of or through their sites, had already drawn heavily from this territory and from such cities as Memphis and Kansas City, both for men and material, leaving Camp Pike badly handicapped. A large proportion of the common laborers, whites and negroes, has been drawn from the cotton fields of the South and is not used to ditch work. The same lack of efficiency is found in a large percentage of those who come to work as carpenters, etc. This condition has required a constant weeding out, and a consequent strenuous exertion to keep the labor forces up to the maximum. Agents for Stewart & Co. have not only combed Arkansas, Missouri, Tennessee and Texas for competent workmen, but large numbers have been attracted from the cities of the North and East. One train brings in fifty plumbers and as many steamfitters from St. Louis; the next imports a band of sixty Mexicans from Chihuahua, San Luis Potosi and Sonora by way of Texarkana. These latter, with their long line of mound-building and rock-hewing ancestry behind them, take naturally to the ditches and are among the most valuable of the laborers. Thousand by thousand the labor force has been increased, until it now reaches nearly 10,000 men and the weekly payroll runs over $225,000. And, in addition to the men, some 1500 horses and mules and a hundred huge motor-trucks are kept constantly at work on the reservation.

ONE OF THE THIRTY PAY STATIONS OF THE JAMES STEWART CO., INC., CONTRACTORS

Transporting to and from work, and feeding and caring for this big army of workmen has been one of the incidental but very important problems the contractors have had to solve along with their actual construction. Every morning half a dozen trains bring thousands of men to the camp from Little Rock, and carry them back at night. Other thousands never leave the reservation. Meals must be provided for all and sleeping places for at least half of the laborers. To do this, barracks, to be occupied later by the soldiers, have been fitted up by the contractor as mess houses, and in these the employees eat and sleep. Twenty of these great dining halls, feeding from 200 to 300 men at a meal, have been opened, and serve as high as twelve thousand meals a day.

The Men on the Job

To accomplish all that has been done at Camp Pike within a few weeks has called for an unusual and highly efficient organization. Under the Government's ruling, there could be no subletting, and it was necessary for the contractors to organize all such branches as plumbing, steam-heating, wiring, commissary, etc., which in strictly commercial operations are usually underlet to specialists in these lines. To take care of and direct the various departments of the work, Stewart & Co. immediately summoned their experts from their offices at New York, St. Louis, Chicago, Salt Lake City and Canada, and in a short time had mobilized a highly efficient organization from nearly every section of the United States and Canada. Many of them came direct from Fort Douglas, where they had already had experience in cantonment building, and the mountain engineers were thoroughly at home in the kind of work called for at Camp Pike. If a hundred buildings had to be staked out and elevations established in a day, it was done. Coöperating closely with the engineers on the staff of the construction quartermaster, they became practically one organization, and all the work, with the exception of water and sewers, was laid out by the company's engineers.

Personnel

Among those directly in charge of the work have been: Major John R. Fordyce, constructing quartermaster; Black & Veatch, consulting engineers; Lawrence V. Sheridan, city planner; James Stewart & Co., Inc., general contractors; H. W. Baum, manager and in charge of construction; Don G. Scott, in charge of engineering and contracts; John F. Rourke, field auditor; Ben. F. Baum and J. W. Bell, general superintendents; Ralph Morris, office superintendent and in charge of time-keeping; P. J. Lewelling, superintendent of sewers and pipe lines; R. R. Reed, superintendent of electrical work; J. B. Evans, superintendent of water supply; J. B. Baum, superintendent of commissary.

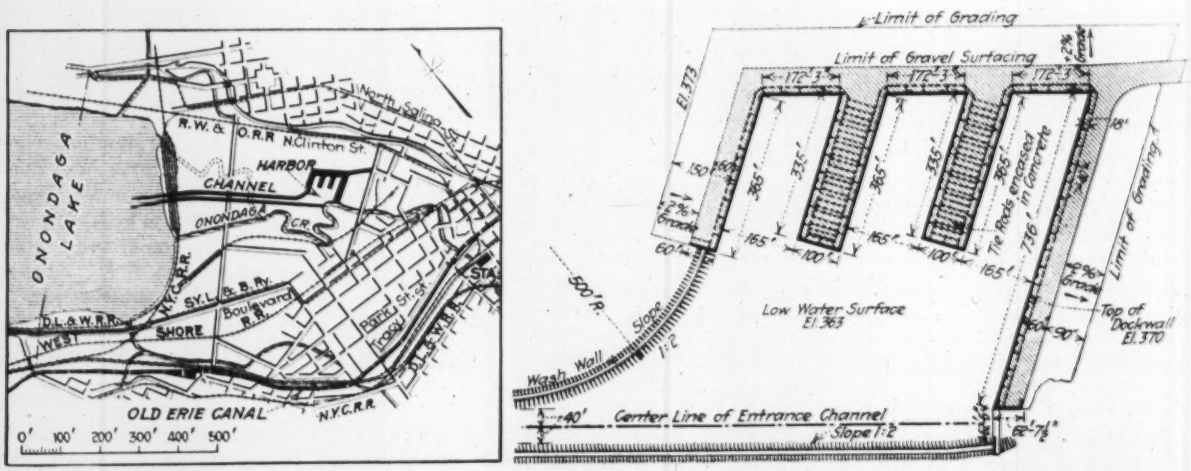
Syracuse Canal Terminal Built Over Old Salt Works

Two Piers with Slips and Turning Basins on Low Ground Used for Many Years for Salt-Drying Tables

THE TERMINAL piers for the New York State Barge Canal at Syracuse, N. Y., are now being built at the head of Onondaga Lake in the midst of flats which for many years were the site of the long timber sheds where brine pumped from wells was evaporated out into the salt which was one of the city's principal products. These flats were in some previous geological period a part of a lake bed, but low water had let them dry—a large area quite near the city's busiest district given over entirely to the land-wasting brine sheds. Here the new terminal is being dug out of the ground. The lake is being brought, by dredging, up to the dock wall, which will be connected by railway and highway to the rest of the city. It is hoped that in time the whole district will be reclaimed for manufacturing and shipping purposes.

Pier Type of Terminal Here

In the New York State Barge Canal there are two types of terminals. One is a marginal dock wall in a slightly widened waterway section, the other a pier construction where lake or large river area is available. In Syracuse the latter type is being built. The old Erie

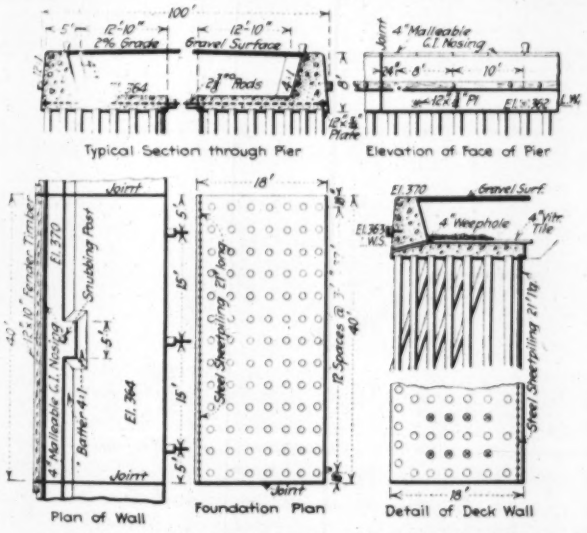


BARGE-CANAL TERMINAL AT SYRACUSE LOCATED NEARLY MILE FROM LAKE

FIRST EXCAVATION WAS MADE ON OLD SALT FLATS

Canal passed through the City of Syracuse. The new Barge Canal main line is several miles north of Syracuse but connection to that city is had through Onondaga Lake to the new terminal being built at its southern end. Here on the flat lands between the various railroads entering the city the terminal channel 80 ft. wide is being excavated for a distance of about 3600 ft. up to the turning basin, which is about a square—800 ft. on the side with a dockwall around three sides from one of which protrudes two piers 350 ft. long, forming in the whole area three 165 x 350-ft. slips and a large basin.

The standard wall construction for dock wall and pier is a gravity section of concrete 3 ft. thick at the top with an outside slope of 12 on 1, and an inside slope of 4 on 1, extending down 8 ft. to a foundation of timber piles, with a backfill up to the level of the wall and a gravel surfacing clear across the pier and for a distance of 60 ft. back of the wall. These walls rest on a concrete floor base 2 ft. thick and 18 ft. wide, which is integral with the wall, and under which the concrete piles are placed. The pier walls, which are 100 ft.



GRAVITY WALLS FOR PIER AND DOCK WALLS

apart throughout, are tied together every 15 ft. by two 3-in. rods with heavy washers at the wall end and turnbuckles for tightening in the middle. The middle section between the floor concrete has been incased in concrete a foot square.

Both the dock and pier walls are in 40-ft. lengths with a straight joint for expansion. Centered in each block, is a snubbing post with a counterfort extension in the concrete wall. The dock wall has a similar design to the pier walls, except that there is no tie rod and

GRAVITY WALL COMPLETE BEFORE SLIP WAS EXCAVATED

there are, in addition, three batter piles to help take the inclined thrust.

There is on the inner face of the wall flooring a continuous line of steel sheet-piles 21 ft. long, which were used in making the wall floor excavation but which are left in place cut off so that they extend a short way into the concrete floor. The piers and the ground for 60 ft. back from the dock wall are floored with gravel surfacing 6 in. thick. From there back a distance of 90 ft. the natural surface is to be graded off to a 2% grade to El. 373, which is 10 ft. above low-water surface, the top of the dock and pier wall being at El. 370. The channel, as in all the Barge Canal, is 12 ft. deep.

When the contractor entered the site it was covered with dilapidated salt-drying sheds founded on a solid

and dry formation which was, nevertheless, filled with roots and trees and presented every indication of having been a marsh before drying out. As shown on the general map this was nearly a mile from the lake shore. The pier and dock walls were first excavated between rows of steel sheet-piling limiting the outer and inner faces of the wall floors. Ordinary Lackawanna steel sheet-piling was first used for this, but it was found to be insufficient to stand the earth pressure when excavated so the arch web type of the same sheet-piling was substituted with very satisfactory results. These piles were driven on the 18-ft. spacing clear around the limits of the wall, and excavation made with clamshell to grade, the clamshell operating on a simple derrick mounted on tracks, which were moved across the site as needed. One view shows the site at the early part of the work, and the other is taken looking along one of the completed walls after the stone had been placed just behind the wall.

This wall construction was completed this spring, and the gravel fill for the flooring is now being placed. At the same time a hydraulic dredge was brought up Onondaga Lake and is proceeding to dig a channel across the flats to the basin. It will be noticed that these flats are the original bed of Onondaga Creek, which will now empty into the turning basin and thence through the channel to the lake. There will be about 1,000,000 cu.yd. of excavation in the whole job.

The terminal was designed and is being built under the direction of the New York State Engineer, Frank M. Williams, with T. B. LaDu, Special Deputy State Engineer, in charge of terminal work. The contract is being carried out under the direction of Guy Moulton, Division Engineer, by the Walsh Construction Co.

Stone-Shipping Dock Is Patterned After Ore-Bin Type

Cylindrical Steel Bins, Loaded from Cars Above, Discharge by Gravity to Steamers—Capacity 7880 Tons

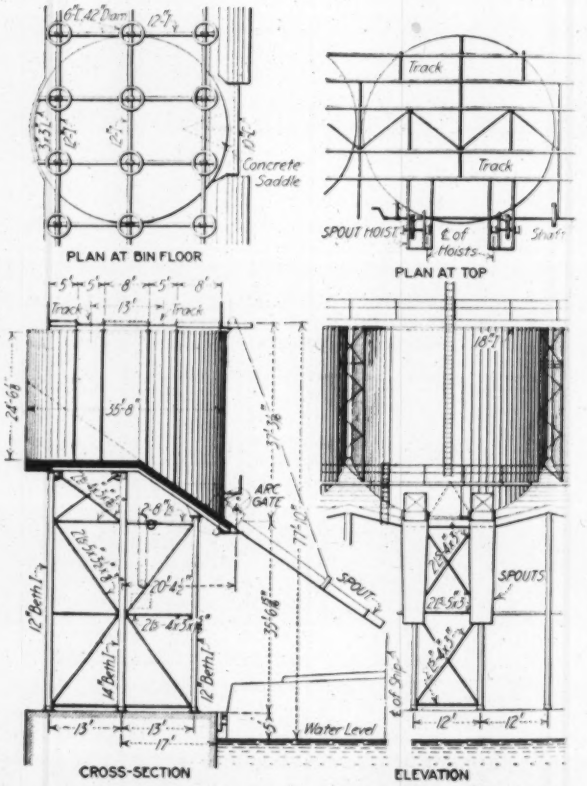
THE Michigan Alkali Co.'s dock for storing and shipping broken-stone at Alpena, Mich., is of the bin type generally used at ore-shipping ports on the Great Lakes, but has several distinctive features. It consists of a steel structure carrying a series of bins, over which run tracks for the cars and from which the stone is spouted by gravity to ships or barges. It has spouts on one side only, as the dock forms one side of a slip, on the other side of which is an old timber dock which will be replaced later with a new structure.

The dock, shown by the accompanying view, is 288 ft. long, with eight circular bins of 985 tons capacity, making a total of 7880 tons. It is on a pier 34 ft. wide, built of cribs which are founded on solid rock and filled with stone and concrete. Anchor bolts for the steelwork were embedded in this concrete. At the shore end is a steel trestle connection to a long earth fill carrying the tracks over which cars are run from the crusher house to the upper level of the dock. This dock was designed and built by the Wisconsin Bridge & Iron Co., of Milwaukee, Wis.

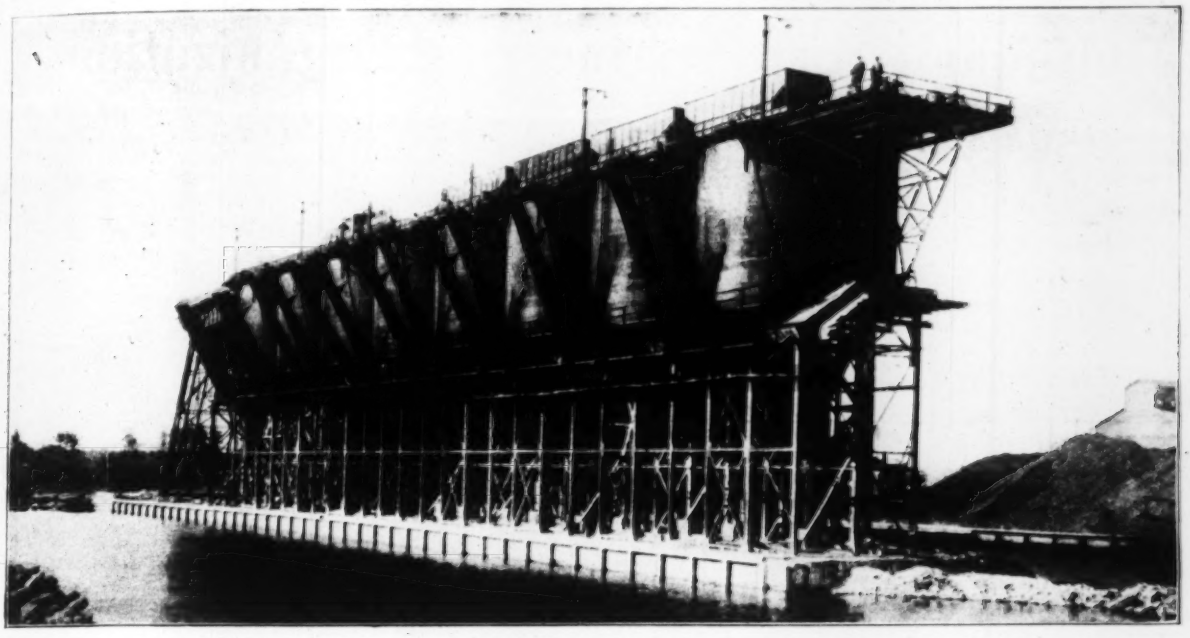
Design of Stone-Shipping Dock

The lower portion of the structure consists of 25 three-post bents 26 ft. wide, spaced 12 ft. c. to c., with diagonal bracing in each third bay. The posts are Bethlehem H-beams, 12-in. for the outer posts and 14-in. for the central posts. The height is about 36 ft. on the shorter side of the bent. The bins are 24½ ft. deep at the rear, where the floor is flat, and 37½ ft. at the front, where the floor is inclined. They are of $\frac{5}{16}$-in. plate for 17 ft. from the top, and thence of $\frac{3}{8}$-in. plate. The framing on top of the bents carries a 24-in. reinforced-concrete slab. The rear part of this is flat, while the forward part is inclined 7 on 10 toward the gates, with a ridge or saddle between the two gate openings. This sloping portion is protected from wear by a 3-in. wood covering.

The steel framing at the tops of the bents supports four rows of columns between the bins, and upon these are plate-girder stringers with track rails laid upon the top flanges. The space between the rails of each track is open, for dumping the stone from hopper-bottom cars. Between and outside of the tracks is a 3-in. plank deck. Along the front of the bins is a walk giving access to the gate-operating machinery. The steelwork was given two coats of Johnson magnetic paint. The interior of the bins is given no special protection against the stone—this not being thought necessary.



DETAILS OF STONE-SHIPPING DOCK, SHOWING CONCRETE FLOOR FOR BINS

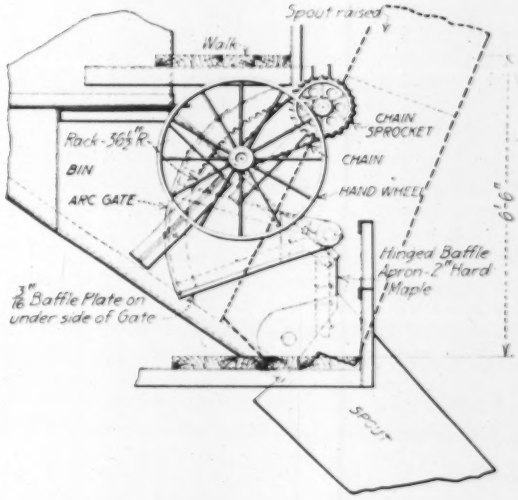


STEEL CYLINDRICAL BINS ARE USED FOR STORING AND SHIPPING BROKEN STONE

A special feature is that the bins are of relatively large capacity, and each is fitted with two doors or gates, thus allowing for more complete discharge of the contents. The large bins reduce the cost of construction and also reduce the maintenance and repair expense for a given capacity. The concrete floor practically eliminates deterioration of the bin bottoms and serves to stiffen the structure, while it also forms a protecting roof over the lower or supporting portion. The two spouts of each bin are 12 ft. c. to c., which corresponds to the standard hatch spacing of lake vessels. As the space between the spouts of adjacent bins is 24 ft., each third hatch is left unserved, and the vessel must be shifted 12 ft. to get its full cargo. This shifting, however, is not objected to by the boat captains.

The use of two doors to each bin makes it possible to reduce the size of the openings so that the flow of stone can be controlled by hand-operated doors. These small doors may be of simple construction. Each opening has a curved or arc gate as shown in one of the drawings, with the convex side facing the bin. On the outer or concave side is a curved rack gearing with a pinion on a short shaft which also carries a 16-in. sprocket wheel. A riveted pintle chain runs over this sprocket and a 4.3-in. sprocket on a shaft carrying a 42-in. hand wheel. Owing to the curvature of the gate its movement in closing is in the direction of the flow of the stone so that it is easily closed. The gates are operated by men on a platform near the bottom of the bins.

The swinging spouts or chutes are steel troughs about 33 ft. long, 52 to 32 in. wide, pivoted at the heel and having near the lower end a bail attached to a cable. They are of light construction and are counterweighted, so that the operating power required and the repair cost are very low. The hoists for these spouts are arranged in groups of four. Each group has a line shaft which is fitted with a friction clutch for each hoist and is driven from a 10-hp. electric motor. By means of a special device, the motor and clutches can be controlled from the operating platform or walk on top of the dock.



HAND-OPERATED SEGMENTAL GATES FOR STONE BINS

This enables one man to operate any of the four chutes from any part of the platform directly above the group, and at the same time to keep control of the motor.

Brockton Activated-Sludge Plans

Plans for the proposed activated-sludge plant for Brockton, Mass., are being made by H. S. Crocker, city engineer, but they will probably not be sufficiently advanced for bids until 1918. The plant will have a capacity of 3,000,000 gal. in 24 hr., with a 4-hr. running-through period.

Building Up an Engineering Organization

—*With Special Reference to the Selection of Men*

BY ARTHUR E. MORGAN
Chief Engineer, Miami Conservancy District, Dayton, Ohio

Engineering is not simply doing a thing. It is first finding the man to do it. The primary requisite of finding the man is to know what qualities are wanted for the particular job. The next is to spot those qualifications in any particular man. Mr. Morgan is the head of one of the big and successful engineering organizations of the day. He tells here what qualities a man had to have before he was asked to join that organization. How those qualities were discovered in a man, is a secret Mr. Morgan finds difficult to analyze, for he writes the editor: "It is about as easy to tell how one knows a good man when he sees him, as it is to pick out the kind of woman to have for a wife."

A BUSINESS or professional organization is efficient or inefficient depending on whether it serves the particular purpose intended. In the prosecution of the present war, the discipline and organization which would be most effective on the battlefield would fail hopelessly if applied to the organization of a research laboratory where anti-submarine devices were being sought. In the one case all wisdom and judgment, except as to details, comes from the higher authority, and the organization is most nearly perfect when it functions without any independent purposes in the individual parts, but simply carries out orders effectively. In a research laboratory it is insight and imagination which count, and the man on the job must personally exercise these qualities.

ORGANIZATIONS DIFFER

So in various fields of engineering, different kinds of organization are necessary to serve different purposes. In such a field as that occupied by the large bridge companies a mechanically exact organization may produce excellent results. In the case of the Miami Conservancy District, such an organization at the inception of the project would have meant failure or serious loss of efficiency. The collection, classification and platting of data was standardized as far as possible, but a large part of the work was exploration or research, and could not be treated in this manner.

When the work was undertaken an outline of the problem was made, and a general scheme of organization prepared, of which the following is roughly a summary:

About fifty men were employed for field surveys, divided into five to seven parties. Each party was in charge of a chief, who also acted as transitman. He had one or two rodmen and one to three helpers or axemen. Under his direction was a transitman or topographer with a similar number of helpers. A single field engineer was employed to supervise these field parties and to standardize field methods. Considerable time passed before all the parties were brought to standard methods, and complete coördination secured between field and drafting room. In the drafting room from 20 to 30 draftsmen were employed, who were under the direction of a chief draftsman. Here, also, considerable time elapsed before standard methods for the somewhat unusual type of work had been developed and thoroughly established.

RESEARCH A BIG PART OF WORK

However, the principal part of the work was of a different character. It consisted of research and investigations in meteorology, hydraulics, earth dam and conduit design, the preparation of a legal code, and numerous other problems where the particular man in charge must be depended upon not only to work accurately but to have the imagination, experience, insight and judgment to get the results. Nearly every important problem was attacked by several different men who worked independently and later compared results, but there could be little supervision of any particular investigation in the usual sense. It was necessary, therefore, to gather together a group of men, each capable of doing sound, dependable work in his field. Moreover, it was desirable that as the project should arrive at the construction stage, the job should have developed a force of men of such experience and training on other work, and of such acquaintance with this project, that they could take charge of construction.

"To associate for a number of years with this type of men is one of the experiences which make life worth living."

During the period of research and exploration it was impossible to foretell what particular line of investigation would be dropped as of no interest, and what line would become of controlling importance. Therefore it was imperative that the men holding responsible positions should not stand upon their dignity but should be willing to lose the identity and importance of their work in that of the project as a whole. Any man to whom the advancement of his personal reputation was first consideration, would be out of place. The perfect organization must be in a continual state of change, each man in it continually tending to gravitate toward the place where he is most useful, whether that place be more or

less important than the one he has filled in the past. Where research is involved, the most destructive criticism by one's fellow workmen must be sought and cheerfully accepted.

Three Qualities Sought in Men

These three principal qualities, therefore, are necessary in an organization built on these lines.

First, the men in responsible positions must be able to carry on research and exploration work, being of such calibre that they are responsible for the results secured.

Second, they must, by personality, training and experience be fitted to take charge of the construction, for their acquaintance with the development of plans is an asset which must not be lost. Of course, not every man doing important work in the organization can be expected to fit into both fields. The most notable research work was done by a man who would not qualify for construction.

Third, they must be of such personality and character that they can merge their personal interests in those

> *"Men must be of such personality and character that they can merge their personal interests in those of the job."*

of the job, expecting a vaguely defined organization to take shape gradually as construction is approached and as the particular efficiency of the various men is determined.

In Plato's "Republic" Socrates is described as outlining the character of the ideal soldier. He must be courageous and ruthless in battle, but gentle and peaceable at home. When one of Socrates' young friends insists in effect that there is no such animal, Socrates remarks that such men are necessary to his scheme, and therefore they must be found. That was the assumption made in organizing the engineering force of the Miami Conservancy District. Thousands of prospects were looked up, through acquaintances, advertisements, technical schools, engineering agencies, and especially by conference and correspondence with heads of projects

> *"Nearly every important problem was attacked by several different men, who worked independently and later compared results."*

nearing completion. Extensive trips were made, during which hundreds of men were interviewed, always with the above specifications clearly in mind. And the kind of men wanted were found.

Responsibility Clearly Defined

The research and exploration problems of the project have been handled in an admirable manner. There has been a degree of coöperation, mutual respect, and good will which is not commonly found; the men are fitted by training and experience to see the construction through to completion and their years of work on the project have given them intimate acquaintance which insures that they will appreciate the significance of the plans.

> *"Where research is involved, the most destructive criticism by one's fellow workmen must be sought and cheerfully accepted."*

As construction approaches a formal organization has gradually been perfected, and status and responsibility have become clearly defined.

Not only has this type of organization been good for our particular job, but the opportunity to associate for a number of years with this type of men is one of the experiences which make life worth living.

Tannery Wastes Studied

Tests of Precipitation and Double Filtration by Government Lead Tanners To Build and Run Working Unit

EXPERIMENTS on the purification of tannery wastes by chemical precipitation with copperas, primary filtration through cinders and secondary filtration through sand, conducted at Luray, Va., and Cincinnati, Ohio, by the U. S. Public Health Service, gave such good results and were so successful in arousing interest among tanneries that three Virginia tanneries combined to build and operate a working-scale plant at Luray with a daily capacity of 10,000 gal. The coöperating tanneries are the Deford Leather Co., Luray; the Leas & McVitty Co., Salem; and Cover & Sons, Elkton.

The original tests, which were made at the first-named plant and at the tannery of Haffner Brothers, Cincinnati, were briefly described by Harry B. Hommon, sanitary chemist, U. S. Public Health Service, Cincinnati, in a paper printed in the July *Journal* of the American Leather Chemists' Society. They show the following results, starting with composite samples from the various elements of the tannery: Suspended solids, reduced from 1200 p.p.m. in the raw wastes to 450 in the settling-tank effluent, to 160 in the cinder, and to 30 in the sand-filter effluent; organic and free ammonia, 70, 55, 30 and 25 respectively; oxygen consumed (30 min. at 96° C.), 900, 530, 205 and 55. The cinder filters were operated at a rate of 250,000 and the sand filters 300,000 gal. per acre. The cinder filter gave 0.29 p.p.m. of nitrites and 6.0 of nitrates; the sand filter, 0.17 and 23.0 respectively.

Conclusions and Application of the Tests

Mr. Hommon expresses the conclusions drawn from the small-scale experiments and their practical application in the larger or 10,000-gal. unit at Luray, as follows:

1. "A storage tank for spent tan liquor to be used, also for treatment of this liquor with lime sludge if it is strongly acid. As it is customary to discharge tan liquor intermittently or but once a day, this tank is required to distribute the flow throughout the day. For the 10,000-gal. plant at Luray, duplicate tanks, each 10

x 6 ft. in plan and 3½ ft. deep, with dosing appliances, are provided.

2. "A solution tank for the ferrous sulphate (copperas) solution. These tanks are in duplicate, each 1½ x 2½ ft. in plan and 2 ft. deep, and have the necessary regulating devices.

3. "A settling tank of sufficient capacity to allow a minimum detention period of two hours computed on the displacement basis. The tank for this purpose at Luray is 20 x 8 ft. by 11 ft. deep, and contains baffles and scum boards.

4. "Cinder filters having a total depth of 5 ft. of cinders, or 4 ft. exclusive of the underdrains. At Luray this is 42 x 30 ft.

5. "Sand filters. Since as good results were obtained in the tests with a depth of sand of 2 ft. as with 5, the sand filter at Luray is divided into three sections having 2, 3 and 4 ft. of sand laid over underdrains which occupy a maximum of 1 ft., sloping to zero at the sides. Separate outlets are provided for each section for taking samples, and provisions were made to increase the depth of the shallow sections if it becomes necessary. These filters, as well as the cinder filters, will operate at a rate of 200,000 gal. per acre per day.

6. "Sludge beds, with sloping bottoms, containing 1 ft. of cinders overlaid with 4 in. of sand. For a 10,000-gal. unit treating the type of wastes produced at Luray, an area of about 600 sq.ft. is required.

BEST RESULTS FROM LOW RATES OF OPERATION

"In the operation of the testing units," states Mr. Hommon, "it was found that better results were obtained by operating the filters at low rates throughout the 24 hours, rather than applying the entire dose for a given rate during the working day. In the permanent unit the settling tank is designed to store enough wastes during the day to operate the filters during the 14 hours the tannery is not in operation. During the latter part of the tests, sand filters 2 ft. deep gave as satisfactory results as the deeper filters, but these filters were only 1 ft. in diameter and the results were not directly comparable. It seemed advisable, however, to construct the larger filter in the permanent unit of three different depths to definitely decide this point.

"It is recognized that a testing station operated under the constant supervision of a technical man may produce better results than can be obtained from the operation of a large plant under the control of an unskilled operator. It is also appreciated that small units like those operated in the tests may be more readily adjusted to temperature changes and other unfavorable conditions affecting the results. It was to learn how far the results obtained from the operation of the testing units could be duplicated in a large plant that recommendations were made to the tanners interested that they build and operate a large unit.

"The plant now under construction at Luray is to be under the general supervision of the government, but this will extend only to making analyses of samples sent to the government laboratory, and to occasional visits for the purpose of suggesting changes in construction and operation."

The 10,000-gal. plant has been in operation since the latter part of June, 1917. Although without technical supervision it is giving results even more satisfactory than those obtained by the small-scale tests.

The Public Health Service will publish a detailed report in the near future containing complete descriptions of the plants and the results obtained. Progress reports will also be published giving the results from the operation of the permanent unit. The general supervision of the work described was conducted by Prof. Earl B. Phelps, Washington, D. C., under the immediate charge at Cincinnati field headquarters of Mr. Hommon.

System Makes Easy Determination of Empirical Formulas

Procedure Laid Down for Use of Logarithmic Paper in Finding Equations for Simpler Experimental Graphs

BY E. W. LANE

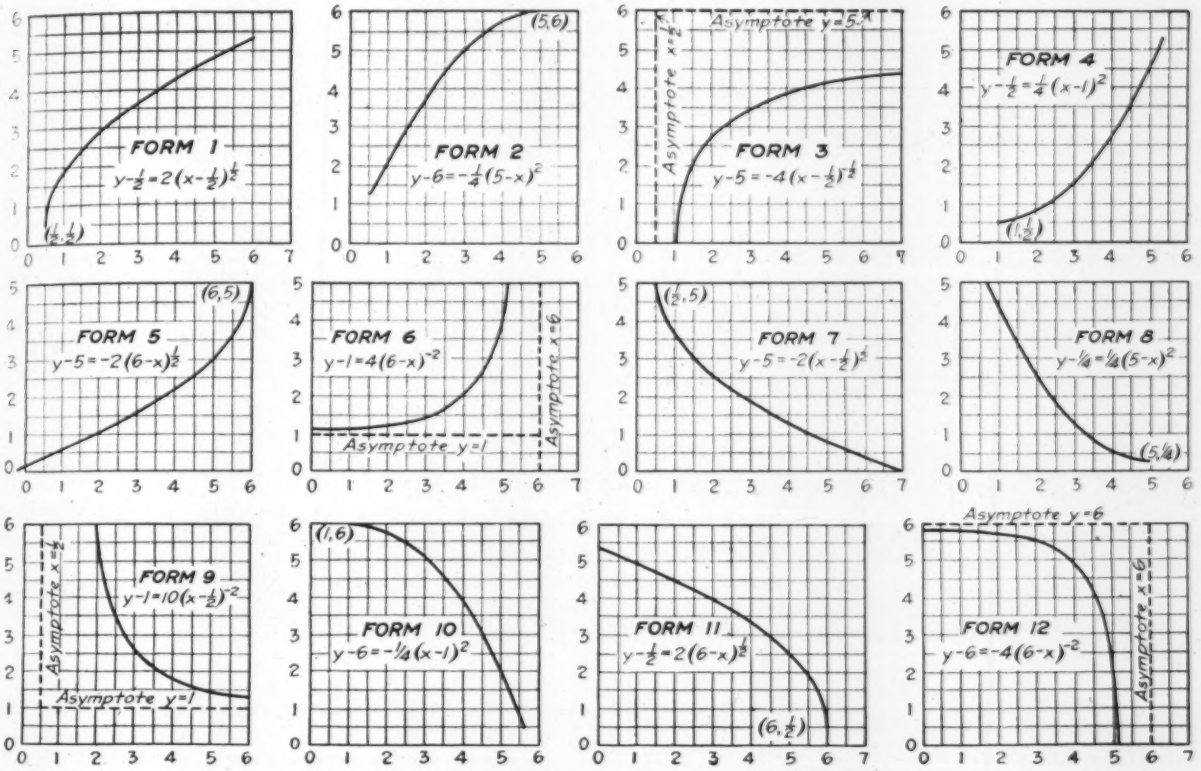
Engineering Department, Miami Conservancy District, Dayton, Ohio

FOLLOWING the universal adoption of the slide rule for making ordinary computations, the use of logarithmic coördinate paper is becoming increasingly common in engineering studies. Some of the properties of such paper are obscure and complex and this article aims to set forth in plain directions a systematic procedure to be followed in one of the most valuable applications of this useful modern device—the determination of empirical exponential formulas to fit given curves.

The use of logarithmic paper in finding equations to express the laws governing phenomena in certain simple classes of cases is already familiar to most engineers. It has been found especially valuable in the analysis of experimental results on account of the great variety of cases in which it can be applied and the ease with which equations may be derived by its aid. An important property of this paper is that any straight line drawn upon it has a simple and easily determined exponential

CHARACTERISTICS OF THE CURVE						FORM OF EQUATION			
Class	Form No.	Ends at	Ends Parallel to Axis of	Point of Greatest Curvature	Asymptote to	Equation Type No.	Sign of C	Sign of n	n ≷ 1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CLASS A	1	b, a	y	b, a		I	+	+	<1
	2	b, a	x	b, a		II	−	+	>1
	3				y=a x=b	I	−	−	
CLASS B	4	b, a	x	b, a		I	+	+	>1
	5	b, a	y	b, a		II	−	+	<1
	6				y=a x=b	II	+	−	
CLASS C	7	b, a	y	b, a		I	−	+	<1
	8	b, a	x	b, a		II	+	+	>1
	9				y=a x=b	I	+	−	
CLASS D	10	b, a	x	b, a		I	−	+	>1
	11	b, a	y	b, a		II	+	+	<1
	12				y=a x=b	II	−	−	

TABULATED CURVE CHARACTERISTICS AND EQUATION FORMS FOR DETERMINING EMPIRICAL EXPONENTIAL FORMULAS



TWELVE TYPICAL EXPONENTIAL CURVES OF THE SIMPLER FORMS

formula, and its use has been largely confined to cases in which the data fall on such a line. Simple formulas may in many cases be found, however, where the experimental data plot on a curve, sometimes even on reverse curves. Some writers have suggested the method of finding the equations of such forms, but no thorough investigation of the subject seems to have been published.

The following discussion was prepared by the writer under the direction of S. M. Woodward, in connection with the design of the flood-prevention works of the Miami Conservancy District. Its purpose is to point out some of the possibilities of the determination of equations by the aid of logarithmic paper and the characteristics of the curves to which the process may be applied. In this article the mathematical principles are not discussed, but an effort is made to present the subject in the form in which it will be of greatest practical use. It is assumed that the reader is already familiar with the theory and principal properties of logarithmic paper, and the case of the straight line will therefore not be considered.

Classification of Curves

Simple exponential equations can be found by the aid of logarithmic paper for a great variety of curves. The formulas are of two general types:

$$\text{Type I, } y - a = c\ (x - b)^n$$
$$\text{Type II, } y - a = c\ (b - x)^n$$

where a, b, c and n are any real numbers. Most graphs, in which one variable is a single-valued increasing or decreasing function of the other, can be closely approximated by one of these two equations.

In this discussion only the cases where $y - a$ and $x - b$ or $b - x$ are positive will be considered, since when they are negative, complications are introduced, a consideration of which will add little to the value of the discussion. Depending on the sign and magnitude of the constants c and n, these two type formulas cover 12 distinct forms of curve, each having different characteristics.

To aid in selecting the equation which will fit any desired curve, the forms here have been classified according to their shape when plotted on rectangular coördinates. In the accompanying table these classes are tabulated, together with the characteristics of the three forms in each class, and the magnitude and sign of the constants which distinguish them. Typical curves of each case are shown in the 12 sketches.

The basis of classification used is the well-known one of differential calculus, depending on the signs of the first and second derivative. In other words, all curves whose slopes are of the same sign, and which are concave in the same direction, are in the same class. For example, class A contains all those forms which slope upward to the right and are concave downward, or for which the first derivative is positive, while the second is negative. There are three of these forms, which, for the purpose of identification, have been numbered 1 to 3 inclusive. Examples of each form are shown and in the table are listed their characteristic features.

Consider a curve of form 1: The second column of the table shows that it ends at the point (b, a). The third

column shows that at this point the curve is parallel to the axis of y, while the fourth column shows that it is also the point of greatest curvature. Column 5 indicates that the curve is not asymptotic to any line. In the last four columns are given the determining features of the formula for the curve. In the first of these, column 6, is given the type of equation for this form—in this case type I, or $y - a = c\ (x - b)^n$. The next two columns show that the signs of both c and n are plus, while column 9 shows that n must be less than unity. In the sketches is a typical curve of this form, the equation being $y - \frac{1}{2} = 2\ (n - \frac{1}{2})^{\frac{1}{2}}$.

Consider a curve of form 3. Columns 2 and 3 of the table indicate that this curve has no finite end. Since the expression for the point of greatest curvature is complicated, it is not included in column 4. Column 5 shows that the curve has two asymptotes, $y = a$ and $x = b$. Columns 6 to 9 inclusive give the characteristics of the formula. It belongs to type I; both c and n are negative, and n may be greater or less than unity. A typical example of form 3 is drawn for which the equation is $y - 5 = -4\ (x - \frac{1}{2})^{\frac{1}{2}}$.

Selection of Type of Equation

The first step in the determination of the formula of a curve is to find to which class and form it belongs. For example, consider a curve which slopes upward toward the right, is concave upward, is asymptotic to a line parallel to the axis of x and possibly also to one parallel to the y axis. The first two characteristics, a plus slope and concavity upward, place this curve in class B of the table, while having asymptotes, places it in form 6. The equation whose graph will most nearly fit the given curve is therefore $y - a = c\ (b - x)^n$, where c is positive and n is negative.

It sometimes happens that the curve is not so easily classified as this example and it is necessary to try out several forms in order to arrive at the best one.

Where a high degree of precision is not required, the determination of the values of the constants can best be made by a cut-and-try process. In order better to understand the method, consider the two type forms:

$$y - a = c\ (x - b)^n$$
$$y - a = c\ (b - x)^n$$

If we replace $y - a$ by another variable, z, and $x - b$ or $b - x$ by w, we have the equation

$$z = cw^n$$

This will be recognized as the equation of a straight line on logarithmic paper. The method of determination of the proper values of a and b is therefore to find those values which will cause $z = y - a$ when plotted against $w = x - b$ or $b - x$, to form as nearly a straight line as possible. The shape of the graph when plotted on rectangular coördinates often indicates approximately the values of a and b. If the curve belongs to one of the forms where n is negative, the asymptotes will be at the values of b and a. If n is positive, the curve will start from the point (b, a) parallel to the x or y axis, depend on whether n is greater or less, respectively, than unity.

Having determined the form of the equation and the approximate values of a and b, plot on logarithmic paper the values of $y - a$ against $x - b$, using these approximations of a and b, x and y being any of the simultaneous values of the two variables the relation between which it is desired to express by a formula. If c is negative, the form of the type equations must be changed to

$$a - y = -c\ (x - b)^n$$

or

$$a - y = -c\ (b - x)^n$$

and the values of $a - y$ plotted against $x - b$ or $b - x$. The plotted points, using the approximate values, will probably lie on a line which is nearly straight. To transform this into a straight line it will be necessary to use somewhat different values of a and b.

Adjusting the Constants

The following rules will aid in determining the nature of the required changes. To alter the values of these constants in such a way that the curve is moved in the direction in which it is concave, increases the concavity, while to move it in the opposite direction decreases the concavity. Thus, if the graph obtained by plotting $y - a$ and $x - b$ or $b - x$ slopes upward to the right, and is concave upward, to make it more nearly straight change a and b in such a way as to move the graph downward or to the right or both. In any such movement those parts of the graph nearer the lower and the left-hand parts of the sheet tend to move faster than the other parts. With the above rules in mind, a little practice will enable one quickly to select a and b of such magnitude that the points will fall as nearly on a right line as it is possible to make them.

From this straight line the values of c and n of the formula $y - a = c\ (x - b)^n$ or $y - a = c\ (b - x)^n$ are easily determined, since, on account of the properties of logarithmic paper, the value of c with its sign is the ordinate as read on the logarithmic paper of the point at which this line crosses the axis along which the values of $y - a$ were plotted; while the value of n, with its sign, is the tangent of the angle which the line makes with axis along which the values of $x - b$ or $b - x$ were plotted.

For Greater Precision

In case greater precision is required than can be obtained by the use of ordinary logarithmic paper, the logarithms of the values of $y - a$ and $x - b$ or $b - x$ may be plotted to any desired scale on rectangular coördinates and the values of a and b adjusted until a straight line is obtained. In this case the value of c, with its sign, is the number whose logarithm is the magnitude of the ordinate where the straight line crosses the axis along which the logarithms of $y - a$ were plotted, while the value of n is the slope of the line with respect to the axis of the logarithm of $x - b$ as was the case with the logarithmic paper.

Panama Canal Traffic Increasing

The total number of ships in seagoing traffic passing through the Panama Canal during the year ended June 30 was 1876, states the *Panama Canal Record*. This compares with 787 the year before, and 1088 the year before that. The cargo carried during the fiscal year 1916-17 was 7,229,255 long tons.

Side-Hill Drainage Allowed To Wash Over Roads

Between Steep Rock Bank and Lake Culverts Are Done Away with and Fill Replaces Usual Retaining Wall

By W. C. Slayton

Assistant Engineer, New York State Commission of Highways, Rochester, N. Y.

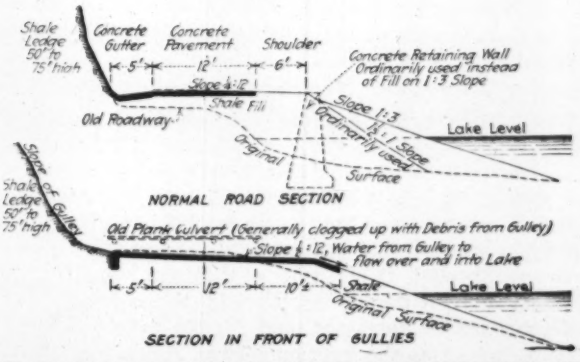
In the design of the Naples-Bristol state highway in Ontario County, New York, one ¾-mile narrow section runs between the shore of Canadaigua Lake and a nearly perpendicular shale-rock ledge. This ledge is pierced on an average of every 300 ft. by steep and narrow gullies which have worn their way into the ledge and empty into the lake, presumably through plank box culverts under the old road. As a matter of fact, due to the extreme steepness of the gullies and the amount of débris brought down with the water, these culverts are generally clogged up, and the water washes over the road instead of flowing under it. This is especially true after heavy rainfall, as the gullies at such times carry off a large volume of water from the hills above.

New Design Does Away with Culverts

In making a design to surmount the difficulty which the gullies present, it was first thought best to try to build the culverts wide and high enough to carry any amount of water that might be brought to them. It was found, however, that in order to get sufficient headroom for culverts of the desired size, the road grade would have to be raised 6 or 8 ft., thereby requiring a large amount of material for the fill. Even then there would be no assurance that the culverts would not sometimes become clogged, as after unusually heavy storms large boulders are washed down the gullies with the smaller débris.

It was therefore finally decided to go to the other extreme, do away with the culverts altogether, and provide for the water running over the road. While heavy rainfalls will undoubtedly wash some débris onto the road, this will be comparatively easy to handle.

The lower of the two accompanying drawings shows how this is accomplished. A concrete road has been designed for this entire section, though for the road on either side of the rock ledge gravel surfacing has been provided. Along the inner edge of the road there is a concrete gutter except opposite the gullies, where a toe wall is placed. From that toe wall to the edge of the road the concrete surface is sloped at ½ in. per 1 ft. and continues for some little distance over the edge of the fill, which tails off into the lake. The toe wall and the aprons extend 12½ ft. either side of the center line of the gullies.



FLAT-SLOPE FILL AND CONCRETE WASHOVER REPLACE USUAL RETAINING WALL AND CULVERT ROAD DESIGN

These washovers are supposed to allow the water to flow freely and still are not steep enough to endanger traffic. The concrete roadway on either side of the washover will have a slope of ½ in. per ft. from the center line to each edge. On account of the regular roadway sloping each way from the center line toward each side and the washovers sloping in one direction only toward the lake, it will be necessary to gradually warp the road surfacing from the regular to the washover section in order to secure this effect.

Flat-Slope Fill Instead of Wall

Normally, for a side-hill road such as this a retaining wall or a steep-slope fill would be used. On this particular section, however, a flat 1:3 fill, sloping into the lake, has been designed. It was first thought that it would be necessary to use retaining walls to prevent the fill from being washed away by the lake. It was finally decided, however, that inasmuch as this fill is to be made from the shale excavated from the ledge, if it is placed on a flat enough slope it will be equally as serviceable as the wall, to say nothing of being considerably cheaper.

As an added precaution against wash, it is the intention to plant willows along the water edge. Small willows can be set at small expense and will eventually grow to such size as to form a protection as well as an ornament to the shore line. The upper drawing of the two shown herewith gives the main section of the road with the slope as designed and the design made but not used for retaining wall and steep slope. Concrete was used for this particular part because it was thought to be warranted on account of the saving in doing away with the large concrete culverts in front of the gullies and because also the washover sections had in any event to be of concrete.

First Cape Cod Canal Engineer Drafted by George Washington

Thomas Machin, the engineer charged by a committee appointed in 1776 by the colony of Massachusetts with the task of making the first survey for the Cape Cod Canal, was "drafted" as an army engineer by George Washington before he could make a fair start on the survey. George Washington's letter to the chairman of the committee which appointed Mr. Machin read:

"The great demand we have for engineers in this department has obliged me to order Mr. Machin hither to assist in that branch of the business."

This bit of American engineering history is recounted by William Barclay Parsons, in a paper (published in the August, 1917, issue of the *Proceedings* of the American Society of Civil Engineers) on the Cape Cod Canal, which was first proposed more than 300 years ago and finally opened to commercial traffic in 1914.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Faster-Flowing Water Does Not Mean More Water

Sir—The writer has been very much interested in General Chittenden's article entitled, "Faster-Flowing Water Does Not Mean More Water," in your issue of Aug. 9. The writer has often had to combat the same fallacy which General Chittenden points out and has found the mental attitude of the average layman very much as described by him.

It appears to the writer that a hasty reading of the article might leave the inexperienced engineer with the idea that there could be no increase in floods in the lower part of the stream due to improvements of the upper reaches. The article itself, however, indicates two ways in which such increases might occur, neither of which affects the main point. The author says:

"It is scarcely necessary to point out that the matter we are discussing should not be confused with the effect of cutting off valley storage. It is well recognized that the cutting off of such overflow throws a heavier burden upon the main channel in time of flood. . . . . For instance, if the Mississippi River were shortened, as it might be, so that a flood entering Cairo would reach Vicksburg two days earlier than by the present channel, that fact would involve no menace if more water did not also come, which would certainly not be the case."

The reader must remember that the elimination of valley storage may greatly increase the floods. This has been demonstrated in the studies of all of our large rivers, but is particularly important in the case of small streams where the improvements are of a very radical nature. This was brought out in the study of the extraordinary flood in the River des Peres of Aug. 19, 1915 (see *Engineering News* of Oct. 14, 1915).

In this instance, which referred to a small stream of only 100 sq.mi. of drainage area, and with a very insufficient channel, the valley storage reached unusual proportions. In attempting to analyze the conditions in order to arrive at the proper size of improved channel, the writer prepared a hypothetical discharge curve based on the elimination of storage. This showed that an improved upper stream of ample capacity would have discharged approximately 20% more water per second into lower reaches.

As General Chittenden points out, this is not in any way due to faster flowing water in the improved channel, but is due entirely to the provision of an ample channel.

Referring now to the second sentence quoted, the fact of the flow reaching Vicksburg two days earlier may be of no material importance in the Mississippi River, but in a small stream of the character outlined above, the fact of a flow reaching a junction point two hours earlier than in the improved channel might have considerable effect on the flow in the lower valley. This would be clearly illustrated by the following:

Assume the time of flow from the headwaters to a junction point in the improved channel to be six hours. Assume the time of flow in the branch at the junction point to be four hours. If the improvement of the upper channel decreases the time of flow of the main stream to four hours also, then the critical condition below the junction is for a four-hour maximum rain instead of the six-hour rain, and on the occurrence of such a rain the flow in the lower valley would certainly be more severe than it could possibly have been if the upper channel had not been improved.

It is evident that any extended channel improvement will involve both a reduction of valley storage and a probability of a shorter concentration of flow, and that the combination of these two factors may introduce important differences along the lower reaches.

These illustrations have no direct bearing on the point of General Chittenden's article, but are offered as a warning that his article should be read carefully and that the reader should not jump at a conclusion from the title.

W. W. HORNER,
Engineer-in-Charge Design of Sewers and Paving.
St. Louis, Mo.

Sir—General Chittenden's theory will not accord with the facts if the channel improvement above a point is so extensive with relation to the water-shed as to produce a more rapid rate of run-off from the drainage area. The theory will be approximately correct only in the case where the improvement of a section of the water course does not affect the rate of run-off from the drainage area above.

Assuming at a point a well defined water channel, improved or unimproved, having a maximum flood discharging capacity within the limits of overflow, a larger waterway opening will be required and the sectional area of the flood will increase in some relation to improvements of the water courses in the drainage area above producing a delivery of the rainfall from the entire area at a more rapid rate in a shorter time. It might well be that channel improvements in the drainage area above could be of such character and extent as to produce an increased sectional area of flood at the assumed point below even if a channel improvement had been made at the latter place.

J. L. CAMPBELL.
El Paso, Tex.

Sir—It is with no little diffidence that the writer undertakes to question the logic of so able a writer as General Chittenden. The startling heading given above means nothing unless consideration is given to the section of the channel through which the water is flowing.

If a volume of water flows through a fixed section at a velocity of 3 ft. per sec. and this velocity is increased to 6 ft. per sec., then the volume carried in a given interval of time will also be increased. To carry the same volume through the section at different velocities, requires that for the higher velocities the hydraulic mean depth must be decreased, and for the flatter slope and lower velocities the hydraulic mean depth must be increased. So it will be seen that the stage or elevation of

the surface of the water is to that extent independent of volume.

The writer is somewhat familiar with the flood problems of the Mississippi River and the menace of cut-offs. Deep bends are common on both the Mississippi and Missouri Rivers. Take for instance a bend ten miles in length with an average slope of 4 in. to the mile. The narrow neck of land separating the upper and lower branches of the bend is, say, one mile wide. The hydraulic head against the upper side of the threatened cut-off is then 40 in. A cut-off now occurs and this head is absorbed by lowering the surface above and raising it below. Close the cut-off again and the head above is restored, the surface of the water on the upper side of the narrow neck is raised and on the lower side it is lowered. To those living behind levees below the cut-offs that have occurred, these facts have been so emphatically demonstrated by actual observations that further proof is not necessary. To them, higher water with its larger flooded area, means more water, and any other construction is a mere quibble; their only means of measurement is gage height. They are interested in volume of flow only so far as it affects stage, or height of water surface, but are quite alive to any change in that particular. The picture of ruin and devastation drawn by the attorney in the Miami Conservancy case quoted was not so far wrong after all.

The influence of storage is by no means so insignificant that it can be ignored. A flood passing Cairo at the rate of over two million second feet passes the mouth of Red River at a rate of about one and a half million second feet. Even within its banks, the storage area of the river in the reach named is 953 square miles.

General Chittenden says that there is "no menace in increased velocity" due to cut-offs and that it is "wholly inconsequential." If he limits the application to rock-bound streams then the writer agrees with him, but it will not do to apply it to alluvial streams. Neither is it true that the increase in velocity due to a cut-off will "be absorbed in the first few hundred feet." We have examples in both the Missouri and Mississippi Rivers where the phenomena relating to cut-offs have been very carefully observed and it has been definitely established that cut-offs affect the slope for many miles both above and below. The increase in velocity does accelerate bank erosion to a very serious extent, and causes a general disturbance of the regimen of the river.

Fixing the banks of a great alluvial river is the largest item in the cost of regulation and control, and it is also indispensable in any such scheme of improvement. It is not surprising then that a threatened cut-off is viewed with no little alarm. The writer cannot agree that all these ideas are "airy nothings" that have merely found "local habitation," for they are based on facts developed in world-wide experience.

Deficient navigable depth usually applies to comparatively straight reaches of river, and not to bends. The bends in the vicinity of Greenville are good examples. In fact so far as cost of improvement is concerned an ideal condition would be realized when curvature with its slope and consequent velocity was such that the stability of the banks would not be disturbed by erosion.

St. Louis, Mo. J. A. OCKERSON.

Show Students How to Observe

Sir—The writer was interested in a letter under the above caption in your issue of May 17, p. 372. Nature study and freehand drawing and sketching from nature are very efficient means of cultivating observation.

There is no good reason for referring particularly to engineering teachers and students. Observing and reasoning should become a habit before the age for entering any college is reached. Likewise there should be a habit of doing some real and original thinking and not that of swallowing whole whatever is printed or told.

The following is one of the numerous instances in the writer's experience of the lack of observation: A railway location was made in a river cañon. Several years thereafter construction was begun. In the meantime, or possibly before the location was made, there occurred a freshet that left unmistakable high-water marks in the numerous piles of drift. Yet the work was staked out, grade pegs were set below the high-water marks, and the grade was actually made by excavating below the driftwood.

The significance of the signs did not occur to the engineers. If others on the work were more observing they made no effort to inform their employers.

Honolulu, T. H. C. H. KLUEGEL.

British Engineers and Founders Agree on Pipe Specifications

Sir—With reference to the controversy in your columns as to cast-iron pipe specifications, perhaps you are not aware that a British standard has been prepared in this country under the auspices of the Engineering Standards Committee, in which both engineers and pipe-founders are represented. The detailed specification will be available for general use in a few weeks.

In view of your own discussion you will be interested to note that interchangeability is to be attained by constancy of external diameter, and that strength is to be determined by a relation between load and flexure. The range of standards is up to 48 in. diameter for socket and spigot pipes, and up to 24 in. diameter for flanged pipes and special castings.

D. HALTON THOMSON,
Chief Eng. Asst., Borough of Portsmouth W.-W. Co.
Portsmouth, England.

[The two clauses relating to interchangeability or uniform outside diameter and to relation between load and flexure are as follows:

"(4) *Constancy of External Diameter*—In order to render the pipes and castings interchangeable it was necessary to standardize the external diameter and allow the internal diameter to vary slightly with the thickness and describe it as the nominal diameter or bore. This has had the effect of enormously reducing the number of patterns, as those for the barrel and socket of any group remain the same throughout.

"(5) *Strength and Testing of Cast Iron*—The tensile strength has been fixed at the minimum of 9½ tons per square inch, and the transverse strength, on the standard 2 x 1-in. bar with supports 36 in. apart, at the minimum of 28 cwt. and deflection of 0.33 in."

Tons of 2240 lb. are of course to be understood.—Editor.]

ENGINEERING LITERATURE

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Revised American Classic and New British Graphic Statics

REVIEWED BY J. P. J. WILLIAMS
First Assistant Engineer, Concrete-Steel Engineering Co., New York City

A TEXTBOOK ON ROOFS AND BRIDGES: Part II Graphic Statistics—By Mansfield Merriman, M. Am. Soc. C. E., and Henry S. Jacoby, Professor of Bridge Engineering in Cornell University. Fourth Edition, Revised and Enlarged; Total Issue, Twenty-Second Thousand. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Limited. Cloth; 6 x 9 in.; pp. 294; illustrated. $2.50.

THE ELEMENTS OF GRAPHIC STATICS: A Textbook for Students, Engineers and Architects—By Ernest H. Sprague, A. M. Inst. C. E. London: Scott, Greenwood & Son. Cloth; 5 x 8 in.; pp. 200; 163 illustrations.

Although these two texts on graphic statics are not directly comparable, since one is a thorough treatment of the application of graphic methods to the analysis of stresses and deflections in roofs and bridges, while the other considers mainly the elementary principles and methods of graphics, nevertheless certain striking differences between the American and British texts are more or less typical. The first of these is seen in the drawing and reproduction of the illustrative diagrams—a matter which is, of course, of the most vital importance in any treatment of graphic methods. The British book is astonishingly weak in this respect; in addition to poorly executed drawings and lettering, there are cases where letters to which reference is made in the text are entirely omitted in the diagrams. The American textbook is wholly satisfactory in this important element of clear and well-lettered drawings.

A second principal requirement for satisfactory treatment of graphic methods is concise and easily followed statements of the principles of the construction and explanations of diagrams used for illustration. In this respect the British text is weak; in fact, an impression of hurried writing and lack of polish is often obtained, as though the text had been rushed to completion to meet a certain time limit. Although in the American treatment the explanation of the practical examples used too often are given undue prominence, tending to obscure the main principles by excessive detail, yet the treatment is, on the whole, quite satisfactory, as is well known by those acquainted with the earlier editions of this classic work. The new chapters on influence lines for stresses and deflections, in which some of the matter is apparently original, add materially to the value of the book and clearly mark its advance over the more elementary work by Mr. Sprauge, who treats influence lines in a separate volume of the Broadway Series of Engineering Handbooks.

In one respect the book by Mr. Sprague is superior to that by Merriman & Jacoby. This is in the important matter of problems—or "examples," as they are called by Mr. Sprague. Instead of giving a few problems at the end of each article, which are obviously to be solved by the methods of that article, as in "Roofs and Bridges," Mr. Sprague gives many differing problems at the end of each chapter, thus forcing the student to select the proper method of solution. The order of presentation in the two treatments is quite different. In fact, there seems little logic in the sequence adopted by Mr. Sprague. This will be seen in the list of chapter headings found in the following discussion of each book.

PART II OF ROOFS AND BRIDGES REVISED

The general character of the previous editions of "Roofs and Bridges," Part II, on graphic methods is too well known to American engineers to require description. The material now added consists mainly of articles on bridge loading and new formulas, a new article treating a special case for the central panel in truss deflections, and three new chapters treating influence lines for stresses and deflections and giving references to American articles on graphic methods, with reproductions of recent photographs of buildings and bridges. The number of pages has been increased from 242 to 304.

The new chapters on influence lines are thorough and up-to-date, that on deflection influence lines following the treatment suggested by D. B. Steinman in the *Engineering Record*, Nov. 25, 1916. Engineers will be particularly interested in the graphic analysis for the K-truss, although it is unfortunate that only a simple-span truss is considered, without extending the analysis to include the cantilever type for which the K-truss is best suited.

To aid in the judgment of the text by those not familiar with Part II of "Roofs and Bridges," the following list of chapter headings in the new edition is given: Principles and Methods (includes moment of inertia, etc.); Roof Trusses; Bridge Trusses; Locomotive Axle Loads; Trusses with Broken Chords; Miscellaneous Trusses; Elastic Deformation of Trusses; Influence Lines for Stresses; Deflection Influence Lines; Reference Literature.

ELEMENTS OF GRAPHIC STATICS

The principal criticisms of this new textbook have already been mentioned. For its purpose, which is evidently to explain general principles in an elementary manner for young engineering students, it is well conceived, and should meet with approval in spite of its obvious shortcomings. The use of such illustrative examples as "flap-doors" and similar nonengineering objects does not add to its value for engineers.

The best indication of the general scope of this little book is in the following list of chapter headings: Composition and Resolution of Forces; the same, mathematically considered; Framed Structures; Superposed and Space Frames; Moments; Roofs; Shear and Bending Moment Diagrams; Relation between Curves of Load, Shear and Bending Moment; Shear and Bending Moment for a Moving Load; Moments of Areas; Stress Distribution on Cross Section; The Line of Pressure.

Hydrology and Its Principles

REVIEWED BY H. K. BARROWS
Consulting Engineer and Associate Professor of Hydraulic Engineering, Massachusetts Institute of Technology, Boston

THE ELEMENTS OF HYDROLOGY—By Adolph F. Meyer, M. Am. Soc. C. E., Consulting Engineer, Associate Professor of Hydraulic Engineering, University of Minnesota. New York: John Wiley & Sons. Cloth; 6 x 9 in.; pp. 487; 287 illustrations, including some on folding plates. $4 net.

The purpose of the author is to clearly set forth fundamental data and considerations relating to the science of hydrology, for the assistance of professional men, teachers and students of engineering, rather than to provide either a text or a reference book on this subject. Problems of hydrology are fundamental in planning and carrying out the works of hydraulic engineering, such as water power, water-supply, irrigation, sewerage and drainage projects, etc., but the treatment of this subject heretofore has been entirely supplemental and in connection with books relating to the various branches of hydraulic engineering.

Beginning with first causes, the atmosphere and water in its various states are discussed in an interesting manner. Precipitation is quite fully treated, including its different forms of occurrence, its measurement and variation. Particular attention is given to maximum precipitation and hourly rates of excessive precipitation, for which very complete data are tabulated. Evaporation from water surface is discussed in some detail and some of the best records of actual observed evaporation given. For the estimate of evaporation based upon data of temperature, relative humidity, etc., the author inclines toward the use of the Dalton formula, with a slightly modified wind coefficient.

The author bases his treatment of the subject of run-off upon the now generally accepted theory that run-off is a residual; that is, precipitation minus losses, rather than a proportion or percentage of precipitation. With this in mind, the water consumed in evaporation from land areas, in transpiration and interception due to vegetation, and the effect of deep seepage are discussed, giving such general information as is now available as well the personal views of the author.

The factors affecting run-off and its division into surface flow and seepage flow are discussed and a number of monthly and daily hydrographs of discharge of streams given. The latter, however, are confined almost entirely to streams in Minnesota and Wisconsin.

The flood flow of streams is discussed chiefly by data of particular occurrences, although a brief statement is made in regard to maximum flood formulæ which have been suggested by different writers. The author leaves this important subject somewhat indefinitely in the mind of the reader and more definite suggestions as to methods of estimating flood flow which he believes desirable would be of value to the engineer. The low-water flow of streams is but sparsely treated, the only data given being for Minnesota streams.

The instruments, methods, etc., used in obtaining stream-flow data are well described, although the author could with advantage more clearly define conditions under which different methods of measurement should be used, with especial reference to the quantity of discharge to be measured. The use of sharp crested weirs for stream-flow measurement should also receive attention.

To supplement the many short-time records of stream flow which are now available through the work of the U. S. Geological Survey, the author suggests the use of the so-called "hydro-physical" method, which, in brief, consists of computing the losses due to water and land evaporation, transpiration, etc., and subtracting these losses from the rainfall. This is a logical method of procedure, but the student should keep in mind that the use of basic diagrams of soil evaporation, transpiration, etc., presented by the author, with variable coefficients, to take into account conditions upon a particular drainage area, requires to a very large degree an intimate knowledge of the characteristics of the drainage area and good judgment in interpreting these conditions.

The author should perhaps state more emphatically that the ideal consideration is always data of run-off over a long period of years and that the use of the hydro-physical method in extending short-time records should be carefully checked and analyzed by comparison with the actual run-off data before acceptance of results.

The general problems of modifying stream flow by storage are well presented and described. The manner of studying the effect of storage and pondage is only briefly touched upon, however, and the treatment of the mass curve and other methods now in use could well be amplified.

This book, although, as the author frankly states, not complete in many respects, will be of interest and value to all who are studying and meeting the problems of hydraulic engineering. It will be found of material aid in indicating logical methods of analysis and drawing sound conclusions in an important field of engineering.

Machine-Shop Engineering

MODERN MACHINE SHOP CONSTRUCTION, EQUIPMENT AND MANAGEMENT: A Work for the Architect, Engineer, Manufacturer, Director, Officer, Accountant, Superintendent and Foreman—By Oscar E. Perrigo, M. Am. Soc. M. E. Second Edition, Revised and Enlarged. New York: Norman W. Henley Publishing Co. Cloth; 6 x 9 in.; pp. 384; 219 figures in the text. $5.

Much information on machine shop requirements and on equipment of interest to the shop architect and structural engineer has here been gathered. There is, of course, still more of greatest interest for the shop managers and superintendents on building construction, improved layout and equipment, shop management, and cost reduction.

The author illustrates what he considers good practice by giving the design, layout and construction adopted for a good-sized plant for the production of medium-sized machinery—a concern having its own foundry, and pattern, carpenter and forge shops, as well as the machine shop and power plant. Steel frames and roof trusses with brick walls are described as the first choice though mill ("slow-burning") buildings and saw-tooth roofs are used for some specific cases and are described at length. Chimney foundations and floors required by various shops are discussed. The topic of floors is handled in a way of particular practical benefit to the architect and structural engineer, since it is written from the shop man's point of view as to what is required. Heating, lighting, power supply, ventilation and the interior transportation lines are discussed.

The author is conservative with regard to "scientific management." He recommends adapting the tools to the work and the materials, the use of standardized performance records as bases of wages, etc., but he does not surrender himself to these ideas in extreme form. He advocates works hospitals, company doctors, mutual-benefit associations, company reading rooms and schools.

Masonry Dams Notably Treated

REVIEWED BY F. TEICHMAN

Engineer, U. S. Reclamation Service, Washington, D. C.

ENGINEERING FOR MASONRY DAMS: By William Pitcher Creager, C. E., M. Am. Soc. C. E. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Limited. Cloth; 6 x 9 in.; pp. 237; illustrated. $2.50.

This book is remarkable for the completeness and methodical arrangement of its subject matter, the logical and concise language used and the careful interpunctuation. It is never necessary to re-read a sentence or paragraph to arrive at its meaning and even the inexperienced reader must be conscious of a literary pleasure in reading the book.

The author begins with the investigations required for the location of a dam and the selection of its type and then limits his discussion to masonry dams. In a very careful way the forces that act upon a dam are separately treated, and finally the rules and equations are established that govern the design of solid non-overflow and solid spillway gravity dams. This subject terminates with the computation of two examples for each of the two kinds of dams. The hollow dam is next considered and again the principles of the design are illustrated by the computation of two examples. Then follows the arch dam. Here the question of relative arch and beam stress is discussed without any further complications than are of interest to the practical designer. A table gives the general characteristics of 34 representative arch dams. The Jorgensen principle of constant central angle is clearly brought out in a few equations, the advantages of such design are critically examined and by way of illustration the well known Salmon Creek dam is given. The multiple-arch dam is noted in a short section containing suggestions sufficient to the experienced designer.

Near the end of the book one chapter treats the preparation and protection of foundations of dams, another the flood flows of rivers while the last chapter takes up the masonry of dams, including architectural treatment, contraction joints, drainage, waterproofing and the regulation of the high-water surface by gates or syphon spillways.

Only relatively small space is allowed to mathematical deductions—short and satisfactory where they occur. Where higher mathematics would be required to arrive at workable formulas, these formulas are given and the reader is referred to specific articles or books. Such questions as the beam action in an arched dam, or the ice pressure on a dam, or the distribution of shear over the dam section, or uplift, are treated by quoting from the best known authorities on these subjects, or by referring the reader to them, or by both. The author derives his own formulas for the maximum inclined stress in the masonry of the dam and for the lower nappe of jet and the corresponding masonry line of spillway gravity dams and gives an interesting graphic comparison of the outline of five representative spillway dams with that derived from his own formula, all reduced to an overtopping head of 10 ft. Many practical sides of the engineering of masonry dams are not treated at large, but references are given to standard articles or books.

The 229 pages of the volume are full of valuable information, made easy of access by the methodical arrangement of the material. The assumptions and recommendations are consistent with good conservative practice, and the title of the book well represents its contents. If the reader feels any regret it is because he does not find treated one of the difficult problems of engineering of masonry dams—outlet control. It may safely be predicted that the work will be of great value to the student and be a counselor and companion to the designer and to the engineer in the field.

Slopes and Rises

REVIEWED BY R. FLEMING

American Bridge Co., New York City

SMOLEY'S PARALLEL TABLES OF SLOPES AND RISES: In Combination with Diagrams of Slopes and Rises and Other Tables—For Bridge and Structural Engineers, Draftsmen, Checkers, Templet Makers, Builders and Vocational Schools—By Constantine K. Smoley, Author of Parallel Tables of Logarithms and Squares, of the I. C. S. Civil Engineer's Handbook, etc. New York: McGraw-Hill Book Co., Inc. Leather; 5 x 7 in.; pp. 300; illustrated. $3.50.

The great amount of work done in the preparation of these tables may be appreciated from the fact that separate solutions of more than 100,000 right triangles were required. The first 35 pages of Part I are given to the explanation and application of the tables. The tables themselves take up the next 200 pages. Eight two-page plates of graphical solutions of right triangles follow. Part II, of 75 pages, is a reprint of certain pages from the author's well known "Tables of Logarithms and Squares."

The tables of slopes and rises are given for bevels varying by $\frac{1}{16}$ in. from $\frac{1}{16}$ in. to 12 in. per ft. At the top of each page is placed the bevel. The given numbers are the bases, varying by $\frac{1}{16}$ in. from 0 to 12 in. and by 1 ft. from 1 ft. to 40 ft. For each base the corresponding rise and slope or hypothenuse calculated to the nearest $\frac{1}{32}$ in. are placed side by side. It will be seen that if the bevel and any side of a right triangle are known, the other two sides can be readily found.

The reviewer doubts if the tables will be put to all the uses pointed out by the author. Evidently their main purpose is the determination of clearances and distances in structural details. Referring to square-end connections, Fig. 12, it will be seen that the distance from the working point to the first rivet of the diagonal is obtained by adding the slopes found in two tables, the clearance distance, and the distance from the end of the diagonal to the first rivet. But with the usual clearances of $\frac{1}{4}$ to $\frac{1}{2}$ in. and a permissible variation of $\frac{1}{4}$ in. or more the desired distance can be scaled with sufficient accuracy from the general layout. Again, the lengths of main members are usually calculated from the same figures used to obtain the bevel.

The tables can be used to advantage when unusual accuracy in detailing is required. They may also be time-saving when the bevel is given or when several lengths are to be determined from the same bevel. On the whole, the practical value of a book of this kind can be established only by trial. The draftsman must decide for himself whether it is better to use these tables or to stick to his usual methods.

Contents of Levee Embankments

TABLES OF CUBIC CONTENTS OF LEVEE EMBANKMENTS: Designed by Arthur Alvord Stiles, State Reclamation Engineer. Austin (Tex.) State Reclamation Department. Paper; 6 x 9 in.; pp. 212. Price on request as long as limited supply is available.

For use in computing the cubic contents of levee embankments and in approach fills to carry roads over them, these tables give, in section I of the work, the cubic contents per 100 lin.ft. of embankments varying in height from 0.1 ft. to 30 ft. by tenths of a foot, with crown widths from 1 to 10 ft. by feet, and with side slopes the same on both sides or differing on opposite sides from 1:1 to 3:1. The second section covers a greater range of heights—from 0.1 ft. to 60 ft.—but only the yardage of the triangular sections is given complete, the yardage of the rectangular central section being for a section 1 ft. wide, which must be multiplied by the width of the crown and added to the yardage of the triangular sections. The third part of the work gives the total number of cubic yards in embankments for complete road approaches and component parts leading to the top of the levee embankment on one side. It is assumed in computing all of these tables that the ground on which the levee and approach fills are to be constructed is level from side to side.

Fortier's Irrigation Revised

USE OF WATER IN IRRIGATION—By Samuel Fortier, M. Am. Soc. C. E., Chief of Irrigation Investigations, Office of Public Roads and Rural Engineering, United States Department of Agriculture. Second Edition. [Agricultural Engineering Series.] New York: McGraw-Hill Book Co. Cloth; 6 x 8 in.; pp. 325; illustrated. $2.

Besides the correction of minor errors this edition of Professor Fortier's book has an addition of eight pages to the article on water measurement, an entirely new article of six pages on sewage irrigation and a comprehensive new chapter of 54 pages on the "Use of Water in Foreign Countries." The section on sewage irrigation was perhaps added to meet the omission in the first edition, noted in *Engineering News*, Feb. 11, 1915, p. 264. It appears to be based chiefly on the late G. W. Rafter's two Water-Supply and Irrigation papers on sewage irrigation, published many years ago, but there is little other information available on the subject. The various additions improve a book that was already meritorious.

Compressed Air in British Mining

COMPRESSED AIR PRACTICE IN MINING—By David Penman, M. Inst. M. E., Certificated Colliery Manager, Lecturer in Mining and Engineering at Fife Mining School, London: Charles Griffin & Co., Ltd. Philadelphia: J. B. Lippincott Co. Cloth; 6 x 8 in.; pp. 221; 113 illustrations. $1.75 net.

American engineers who may desire to know something about the use of compressed air for mining work in British possessions will be glad to see this book, for we are told that the use of air in English mining has not developed as much as is warranted, and that there has not been a text from which representative practice could be learned.

The first two chapters, on the thermodynamics of air compression and expansion, and the sections on compressor requirements and power transmission by air, will be lightly passed over by American readers—in view of other adequate treatises of those phases which are not affected by territorial considerations and local ideas.

Much interest should center in the descriptions of English compressors, particularly the "Inbye" type, those intended for use underground. Coal cutters, rock drills, etc., are not neglected. The various forms of mechanism described will be familiar to American users but the makers will appear less so.

Brick Manufacturers Issue Textbook

A TEXTBOOK ON BRICK PAVEMENTS—By Clark R. Mandigo, A.B., M. C.E., Assoc. M. Am. Soc. C. E., Kansas City, Mo.: Western Paving Brick Manufacturers Association. Cloth; 5 x 8 in.; pp. 126; 42 illustrations. $1.50.

Formerly assistant city engineer of Kansas City, Mo., Mr. Mandigo must have had extensive opportunity to study this type of pavement, so much used in the central and middle western states. The book is written for the Western Paving Brick Manufacturers Association, but is unusually free from bias, even though especial emphasis is laid on the virtues of the so-called "vertical-fiber" brick—the unpatented type advocated by this association. Fair treatment is accorded the Dunn wire-cut-lug block, but points of difference are given and an acceptable case made for the less well known method of manufacturing block suitable for street paving.

Besides this matter, there is a historical sketch of road building development; a statement of the factors of highway economics; a satisfactory treatment of brick manufacture, sub-grade and foundation construction, the composition and method of handling the bedding course and the laying and grouting of the brick; a consideration of certain paving problems; and the specifications for paving with brick which are recommended by the Western Paving Brick Manufacturers Association.

Lighthouse Construction

LIGHTHOUSES AND LIGHTSHIPS OF THE UNITED STATES—By George R. Putnam. New York: Houghton Mifflin Co. Cloth; 6 x 9 in.; pp. 294; illustrated. $2 net.

From early days the building of lights has been the most picturesque of engineering constructions. The constant struggle that the building of a lighthouse involves and the pitting of man's strength against the forces of nature are perhaps more obvious than in any other line of engineering work so that the story of lighthouse building appeals to every engineer, even though he has never smelled salt water. Mr. Putnam for many years has been connected with the Lighthouse Service of the United States. His book is based on authoritative knowledge within his own experience and considerable searching through the records of the offices at Washington. The result is more than a technical book; it is a story interesting to the engineer as a man and as a practitioner.

Cost Data for Builders

THE BUILDING ESTIMATOR'S REFERENCE BOOK: A Practical and Thoroughly Reliable Reference Book for Contractors and Estimators Engaged in Estimating the Cost of and Constructing All Classes of Modern Buildings; Giving the Actual Labor Costs and Methods Employed in the Erection of Some of Our Present-Day Structures, Together with All Necessary Material Prices and Labor Quantities Entering Into the Cost of All Classes of Buildings—By Frank R. Walker, author of "Practical Cost Keeping for Contractors." Second edition revised. Chicago (168 North Michigan Ave.): The Author. Leather; 4 x 7 in.; pp. 3540; illustrated. $5.

In these days when prices have to be revised weekly, records of cost data are more than ever only comparative. To those who can judiciously balance past costs

with probable present ones, Mr. Walker's handbook should be very useful. It is almost three times as large as the first edition (*Engineering News*, Feb. 17, 1916, page 318) and contains therefore a proportionate increase of material. Its field is very large, extending over all of the details connected with building work of any sort. Even assuming its unit figures to be far off present values, it cannot fail to be of use to anyone concerned with building work.

For Hydraulic Engineers

Two papers for hydraulic engineers have been reprinted separately from the *Journal of Agricultural Research* for April 23, 1917. One is "The Venturi Flume" (see also *Engineering News*, Aug. 10, 1916, page 271), and the other is entitled "Flow Through Submerged Rectangular Orifices with Modified Contractions." Both are by V. M. Cone, Irrigation Engineer, Office of Public Roads and Rural Engineering, United States Department of Agriculture, and are based on studies in the hydraulic laboratory of the Colorado Experiment Station, at Fort Collins.

Bituminous Road-Surfacing Materials

Two pamphlets on bituminous road-surfacing materials have been issued by the Ontario Department of Public Highways (Toronto). One is entitled "Bituminous Surface for Macadam Roads: The Selection of Materials and Methods of Testing," by G. Cameron Parker. The other, "Specifications for Bituminous Materials," contains condensed specifications supplementary to the first-named pamphlet, which seemingly might far better have been included with the first.

Tells How To Study

Based on his long experience, wide observation, extensive reading and deep reflection, Dr. George F. Swain, Gordon McKay Professor of Civil Engineering in Harvard University and Massachusetts Institue of Technology, has written an interesting pamphlet on "How To Study." (New York: McGraw-Hill Book Co., 25c.) The book is addressed primarily to college students and their instructors, but in interest and possible helpfulness it is far broader.

PUBLICATIONS RECEIVED

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

MORTALITY STATISTICS, 1915—Washington, D. C.: Bureau of the Census. Cloth; 9 x 12 in.; pp. 707.

ADVANCED FIRST-AID INSTRUCTIONS FOR MINERS: A Report on Standardization: By a Committee of Surgeons: G. H. Halberstadt, A. F. Knoefel, W. A. Lynott, W. S. Rountree and M. J. Shields. Washington: Bureau of Mines. Paper; 5 x 6 in.; pp. 154; illustrated.

Much of the information here given would be as useful in other fields of first-aid work as in mining.

AMERICAN ASSOCIATION OF PUBLIC EMPLOYMENT OFFICES: Proceedings for 1916. Washington: Bureau of Labor Statistics. Paper; 6 x 9 in.; pp. 92.

ANTHRACITE AND BITUMINOUS COAL: Report of the Federal Trade Commission, June 20, 1917. Washington: The Commission. Paper; 6 x 9 in.; pp. 420.

Contains much statistical and other information on various phases of the coal industry, together with the recommendations of the commisison.

AMERICAN CONRETE INSTITUTE: Proceedings of 1917 Convention—H. D. Hynds, Secretary, 30 Broad St., New York City. Cloth; 6 x 9 in.; pp. 590; illustrated.

CALIFORNIA DEPARTMENT OF ENGINEERING: Report December, 1914, November, 1916, Sacramento: The Department. Paper; 6 x 9 in.; pp. 208. Includes Appendix B, reprint of Bulletin No. 2, Irrigation Districts of California 1887-1915, pp. 148; Appendix C, reprint of "Investigations of the Economical Duty of Water for Alfalfa in Sacramento Valley, Calif., 1910-1915," pp. 78; and Appendix D, "Preliminary Report on Conservation and Control of Flood Water in Coachella Valley, Calif.," pp. 31, illustrated.

STATISTICAL ABSTRACT OF THE UNITED STATES, 1916—Washington, D. C.: Superintendent Public Documents. Paper; 6 x 9 in.; pp. 769. 50 cents.

WISCONSIN RAILROAD COMMISSION: Digest of Decisions Published in Vol. I to XV, 1905 to 1915—Compiled by Harold L. Geisse, Secretary. Madison, Wis.: The Commission. Cloth; 6 x 9 in.; pp. 805.

THE COAL FIELDS AND COAL INDUSTRY OF EASTERN CANADA. By Francis W. Gray. Ottawa, Ont.: Canada Department of Mines Paper; 7 x 10 in.; pp. 67; illustrated.

AUSTRALIAN PRICES, LABOR AND INDUSTRY; Prices, Purchasing-Power of Money, Wages, Trade Unions, Unemployment, and General Industrial Conditions, 1916. By G. H. Knibbs, Commonwealth Statistician, Melbourne, Australia. Melbourne: McCarron, Bird & Co. Paper; 6 x 9 in.; pp. 586. 2½ shillings.

CHEMICAL AND BACTERIOLOGICAL EXAMINATION OF LONDON WATERS, 1916-17. By Dr. A. C. Houston, Director of Water Examination, Metropolitan Water Board, London, England: P. S. King & Son. Paper; 8 x 13 in.; pp. 16. 2½ shillings.

Notwithstanding reduction to 16 pages, compared with 40 and 61 for the two previous years, this report contains many interesting data, including observations on chlorination and 48 microphotographs of the suspended matter in 0.05 c.c. of water. The latter were designed to show the blocking effect of algae growth on filters.

DISINFECTION OF TANNERY WASTES: By D. D. Jackson [Columbia University, New York City] and A. M. Buswell. [Reprinted from "Journal" of American Leather Chemists Association, June, 1917.] Paper; 6 x 9 in.; pp. 253.

HANDBOOK OF SHIP CALCULATIONS, CONSTRUCTION AND OPERATION: A Book of Reference for Shipowners, Ship Officers, Ship and Engine Draftsmen, Marine Engineers and Others Engaged in the Building and Operating of Ships. By Charles H. Hughes, Naval Architect and Engineer. New York: D. Appleton & Co. Flexible Leather; 5 x 7 in.; pp. 739; illustrated. $5.

NEW JERSEY PUBLIC UTILITY COMMISSIONERS: Findings and Decisions, July, 1915, to December, 1916. Trenton, N. J.: The Commission. Cloth; 6 x 9 in.; pp. 613.

NEW YORK STREAM GAGINGS, 1915-16. Albany, N. Y.: State Engineer and Surveyor. Cloth; 6 x 9 in.; pp. 453; many tables; illustrated.

THE RATIO CHART FOR PLOTTING STATISTICS: By Prof. Irving Fisher, Yale University. [Reprinted from "Quarterly Publications," American Statistical Association, June, 1917.] New Haven, Conn.: The Author. Paper; 6 x 9 in.; pp. 24; illustrated.

THE SUBMARINE AND KINDRED PROBLEMS—Bulletin No. 1, Naval Consulting Board of the United States, 13 Park Row, New York City. Paper; 6 x 9 in.; pp. 16.

Information and instructions for those offering suggestions and inventions for coping with submarines.

TRANSACTIONS OKLAHOMA SOCIETY OF ENGINEERS—Vol. III, 1917. By H. V. Hinckley, Secretary. Oklahoma: The Secretary. 6 x 9 in.; pp. 56; illustrated. $1.

THE USE OF THE PANORAMIC CAMERA IN TOPOGRAPHIC SURVEYING: With Notes on the Application of Photogrammetry to Aërial Surveys. By James W. Bagley. Washington, D. C.: United States Geological Survey. Paper; 6 x 9 in.; pp. 88; diagrams and folding plates of halftones and maps.

A remarkably interesting and suggestive review of this relatively new and very promising field.

WATER-SUPPLY PAPERS U. S. GEOLOGICAL SURVEY: Surface-Water Supply of the United States—Nathan C. Grover, Chief Hydraulic Engineer. Paper; 6 x 9 in. At prices named below, from Superintendent of Documents, Washington, D. C.

No. 391: 1914. Part I. Pacific Slope Basins in California. H. D. Mcglashan and F. F. Henshaw, District Engineers. Prepared in coöperation with the State of California. Pp. 328; 30 cents.

No. 394: 1914. Part XII. North Pacific Drainage Basins. Lower Columbia River and Pacific Drainage Basins in Oregon. F. F. Henshaw and G. L. Parker, District Engineers. Prepared in coöperation with the States of Oregon and Washington. Pp. 180; 15 cents.

No. 405: 1915. Part V. Hudson Bay and Upper Mississippi River Basins. W. G. Hoyt and A. H. Horton, District Engineers. Prepared in coöperation with the States of Minnesota, Wisconsin, Iowa and Illinois. Pp. 211; 20 cents.

THE ENGINEER IN FIELD AND OFFICE

A DEPARTMENT DEVOTED TO DETAILS OF THE DAY'S WORK

Pave Steep Grade with Stone Cubes

STONE PAVING has been laid for 300 lin.ft. on a 7% grade on Grafton Ave., at Dayton, Ohio, as it is considered that the wood-block paving used elsewhere on this street would be dangerously slippery. Wood blocks are not used on grades steeper than 1% at Dayton, though in other cities they are sometimes used on heavier grades, the blocks being separated by lugs or strips of lath so as to give a good hold.

The stone paving is of the Durax type, and is costing $3.75 per sq.yd. The blocks are 3½-in. cubes laid on a

STONE-CUBE PAVING ON 7% GRADE AT DAYTON, OHIO

1¼-in. sand cushion on a 6-in. concrete base, and flushed with a 1:1 cement grout. Before grouting the pavement is rolled with a hand roller. A gang of five men can lay about 150 sq.yd. per 8-hr. day.

The city's specifications for this type of paving call for granite with a crushing strength of about 30,000 lb. per sq.in., and a toughness of 12 as determined by the method employed by the U. S. Office of Public Roads. The cubes are specified to be not more than 4-in. or less than 2¾-in., and those used on any one city block must not vary more than ¾ in. That is, the cubes used on any block must be 2¾ to 3½ in., or 3¼ to 4 in. The joints must be ¼ to ½ in. wide. Coarse, dry gravel or crushed stone is spread over the surface and swept into the joints, so as to fill them to a depth of about 1 in. and the paving is then rolled with a 5-ton roller and sprinkled with enough water to moisten the 1:4 mortar cushion. Both cement-grout and asphalt filler are included in the specifications. The work is being done by Edward Ryan, contractor, under the direction of J. E. Barlow, director of public service, and F. O. Eichelberger, city engineer.

How One Steel Structure Failed and Another Stood

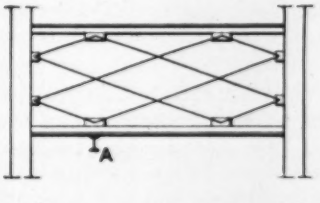
BY R. FLEMING
American Bridge Co., New York City

THE PORTALS of a 200-ft. railroad span were made as shown in the left-hand of the two drawings herewith. The manufacturing company to which it belonged wished to carry a monorail system across the bridge, and attached a row of 12-in. I-beams to the intermediate struts and the portals. There was no trouble at the intermediates, but when the load came to the end the portal gave way, although the flanges and web members were considerably larger than those of the intermediates.

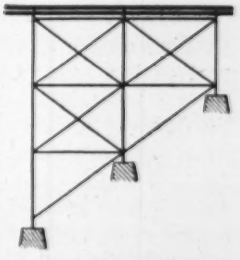
A glance at the portal shows that having no triangular web system it could not carry heavy loads at *A*. It was strengthened by the addition of a 3 x ½-in. flat connecting vertically the gussets above the I-beam, and one in the corresponding place on the other side of the portal. The flats were connected to the gusset plates by two bolts at each end. Since then loads of two tons and more have been on the monorail without causing any trouble.

The right-hand sketch shows a trestle on which cars were run from the headframe of a coal mine. The erecting firm rendered a bill to the fabricating company for reaming holes to make field connections match. The fabricating company's engineer could find no errors in the working drawings nor in the shopwork and insisted that the trouble came from the piers not being on the same level. The matter was left to the purchaser, who finally decided that the fabricating company should pay the bill rendered.

Some months later the engineer visited the site and found at the high corner a clear distance of an inch between the bottom of the base plate and the top of the pier. This upheld him in his former contention that there had been an uneven settlement of the piers. But light cars had been running over the structure daily. It was evident that the vertical reaction was carried by the diagonals at the top and bottom of the end post. It was fortunate that only empty cars had been run over the trestle. When the space between the base plate and top of the pier was filled, loaded cars could be carried.



PORTAL FAILED WHEN I-BEAM WAS LOADED



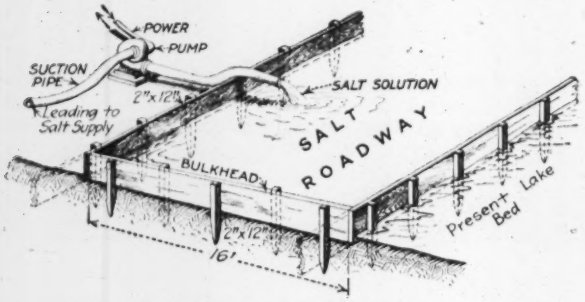
UPPER COLUMN WAS FREE FROM PEDESTAL

Construct Utah Highway of Solid Salt

By LeRoy W. Allison
Newark, N. J.

A UNIQUE roadway of solid salt, forming a part of the Wendover highway in Tooele County, Utah, is projected by the Utah State Road Commission. Between Timpie and Wendover the line of the highway traverses a flat area, crossing at one point a salt bed about 7 miles wide. For a considerable portion of the year this bed is covered with water which, while it thoroughly saturates the roadway, is never of sufficient depth to impede the progress of vehicles. When dry, the bed is found to make an admirable pavement, with salt 2 to 3 ft. deep, hard and smooth, and with a tendency to cool the rubber tires of motor-driven vehicles.

The plans of the commission provide for the establishment of wooden bulkheads of 2 x 12-in. plank 16-ft.

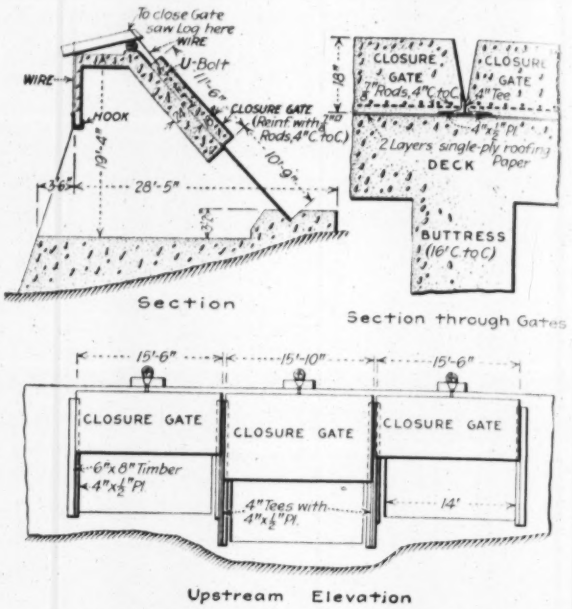


SIMPLY CONSTRUCTED BULKHEAD RETAINS SALT SOLUTION UNTIL EVAPORATION IS COMPLETE

wide and made practically watertight. The construction which will be followed is shown in the accompanying illustration. The pump installation, drawing its supply from lakes of heavy salt water, will pump continually into these trenches, replacing evaporation and leaks until the roadway is formed of crystallized salt to the desired depth. About 40 miles of pavement is to be built by this process and the cost, as estimated, should not run over $1500 per mile. If at any time before construction it becomes desirable to widen the roadway, this could be done without any material addition to the cost.

Concrete Slabs Slide to Place on Deck of Dam to Make Closure

ON the construction of the dam at the new hydroelectric plant of the Cumberland County Power & Light Company at Hiram, Me., on the Saco River, water was allowed to flow through the dam during the main building period, three openings being left in the lower part of the deck. Closure was then accomplished by three reinforced concrete gates which were cast upon the deck of the dam as shown and each held in position by a wire rope attached to log anchored under the opposite wall of the dam by a second rope and hook. Each closure gate was reinforced both ways with ⅞-in. square rods spaced 4 in. on centers and was provided with a U-bolt by which the wire attachment was made. To prevent adhesion between the closure slabs and the deck of the dam, two layers of single-ply roofing paper,



SLABS SLID DOWN DECK OF DAM ON GREASED TARPAPER TO MAKE CLOSURE

greased between layers, formed the base upon which the concrete was poured. The closure gates were about 16 ft. high, 18 in. thick and 15 ft. wide, sliding downward between guides composed of 4-in. tees flanked by 4-in. by ½-in. plate on each side. By sawing off the log above each gate on the top of the dam the slab was released and slid into place seating against a concrete recess at the bottom of the deck, as shown in the cross-section.

Photographic Survey of Proposed Railway Route

A PANORAMIC photographic survey of the route of the proposed Oregon, California & Eastern Ry. has been made in order to show the character and possibilities of the country to persons interested. The outfit used was a "Circuit" camera capable of making a picture 8 in. wide and up to 4 ft. in length. The camera revolves on the head of the tripod and is driven by clockwork so as to cover any desired degree of a circle. From a high point it was possible to cover a distance of 10 to 30 miles. In most cases it was found practicable to set up on a mountain or butte in such a position as to take a view from one valley to another, the points being selected by the engineer. Each picture was begun at about the point where the previous one ended.

It required 31 pictures, each 3 to 4 ft. long, to cover the entire route. This work consumed 19 days, as much time was taken in getting to and from the view-points. Pictures were taken only under favorable conditions of light, atmosphere and absence of wind, in order to get good results. After the photographs had been made, the chief engineer had a draftsman plot the line of the survey upon each picture, so as to show the cuts, fills, structures and other main features. The photographic work was done by Charles R. Miller, of the Miller Photo Co., Klamath Falls, Ore. It was ordered by Robert Strahorn, of Portland, Ore., president of the railway company.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

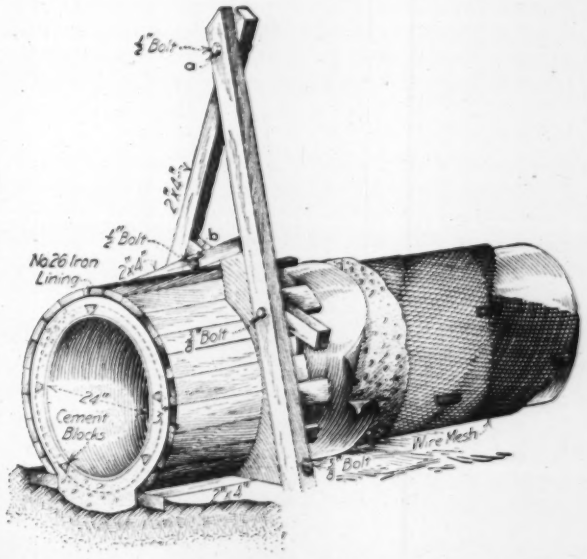
Steel Pipe Line Covered with Concrete Without Disturbing Flow

By H. R. Case
Manager, Temescal Water Co., Corona, Calif.

LONG stretches of old riveted-steel water pipe have been successfully incased in reinforced concrete with an economical method in use by the Temescal Water Co., Corona, Calif., for the past four years. In the light of the present high price of steel plates the work may be of interest to others having pipe lines to replace.

These details were worked out more particularly for use in covering 10,000 ft. of 24-in. riveted-steel pipe line used as inverted siphons working up to 80 ft. head. This line was laid 30 years ago and is beginning to give way near the ends of the siphons, and where light weight steel was used on account of low heads. Possibly 95% of the iron is still in the pipe, but it has rusted badly and pitted particularly at the seams, so that it has been necessary to make repairs during the irrigation season. The system not only protects the outside of the pipe and prolongs its life by the jacket of reinforced concrete, but eventually utilizes all the iron in the old pipe, and when it has disappeared leaves a reinforced-concrete pipe without joints, sufficiently strong to carry the pressure.

FORMS BLOCKED FROM GROUND, PIPE HUNG FROM TRIPOD



OLD STEEL INSIDE FORM FOR NEW CONCRETE PIPE

The drawing shows the details of the wood form used in covering the 24-in. pipe. The forms are constructed of Oregon pine and lined with No. 26 black iron, which saves not only the forms but much material, making a smooth outside surface to the finished pipe. Forms for 24-in. and larger pipe are made in 8-ft. lengths, while the smaller sizes are made up in 12-ft. lengths.

After the steel pipe is uncovered it is thoroughly scraped and cleaned with steel brushes. The ground under the pipe is then shaped to the required depth, the pipe being supported on wood blocks until the forms are set. Bedplates of 2 x 4s are then spaced with a template, similar to the end section of the form, on each side of the pipe to support the forms when in place. The wire-mesh reinforcement cut to 50- or 75-ft. lengths is then wound spirally around the pipe and supported where the edges unite by small cement-mortar blocks made in the form of truncated pyramids, 1½ in. high, 2 in. square at the base and ¾ in. at the apex, which is placed next to the pipe. A man with a hand mold will make 2500 or 3000 of the small blocks in nine hours. The edges of the mesh rest on the base of the little pyramids, thus keeping the wire mesh spaced a uniform distance from the steel pipe or forms. As the blocks are placed, the edges of the wire mesh are tied together with No. 24 soft stovepipe wire.

The forms are then placed on the 2 x 4s and held rigid by the two ½-in. bolts as shown. The wood blocks supporting the pipe are removed, and the pipe is held in place by a strand of wire and a turnbuckle clamp until the form is filled to a point where the concrete will

support the pipe. The concrete is a 1:2½:1 mixture of cement, sand and crushed rock or screened gravel of ¾-in. maximum size. It is mixed by hand and poured rather wet, being worked to place with a light rod and by tapping the forms with a hammer. In laying the pipe up hill the top openings, as the forms are filled, are closed with covers clamped to place until the concrete sets slightly, when the covers are removed and the surface is well troweled and smoothed. The next morning the forms are removed, and the pipe is painted with neat cement. The pipe is then covered with soil and kept wet for two weeks.

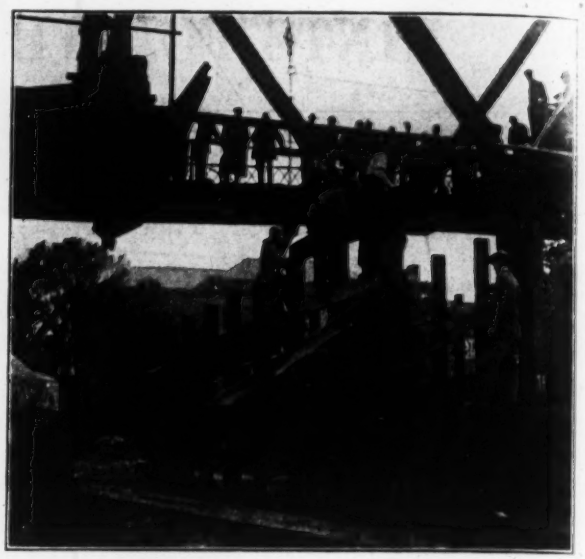
Twelve men will easily build and backfill 140 ft. of 18-in. pipe, 100 ft. of 24-in. or 80 ft. of 30-in. pipe in a day of nine hours. The company is replacing 30-in. steel pipe under 40-ft. head, placed on bridges, with concrete siphons of the same size, at a cost of $2.50 per foot, including the ditching, using collapsible inside forms. Covering 24-in. pipe, including the digging, costs $1.70 per foot, and 18-in. pipe $1.40 per foot. Cement is $2.30 per barrel and labor from $2.25 to $2.50 per day. The mesh used is selected from the stock of the United States Steel Products Co. and varies with the size of pipe and head.

Support Old Steel Spans While Building Arch Bridge Beneath

By R. W. Gearhart
County Engineer, Buchanan County, Independence, Iowa

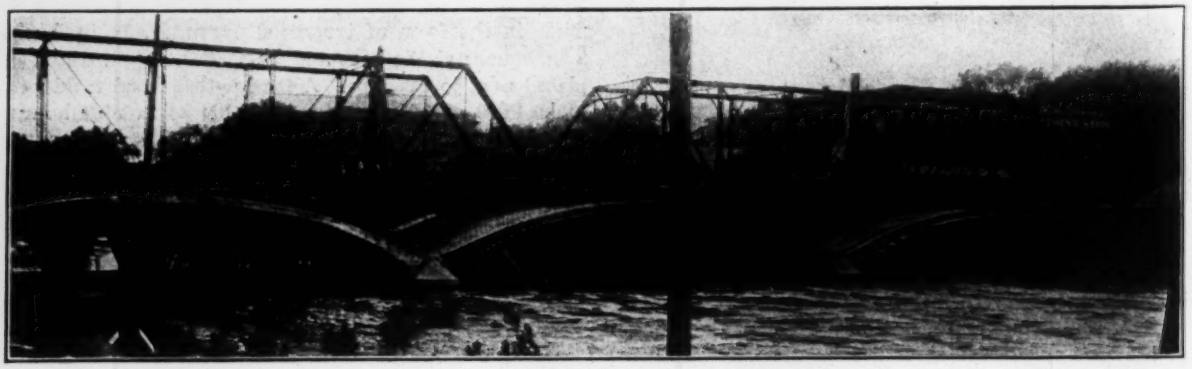
TWO STEEL spans of an old bridge at Independence, Iowa, were suspended and used to maintain traffic and also as a working platform during the construction of a three-span arch concrete bridge directly beneath it, which has recently been completed under the supervision of the writer.

A clause in the contract required the maintenance of a foot bridge during construction, and the contractor decided to support the old bridge in place rather than build a temporary foot bridge, as the course chosen made it possible to use the old bridge in placing the concrete and earth fill required for the new one. After the new bridge was done it was easy to dismantle the old steel spans on it without the necessity for falsework. The east abutment of the new bridge, which consists of three 80-ft. span arches, was located inside of the old abutment, but the west abutment was so located that the old abutment had to be removed. The west end of the west span of the steel bridge was therefore supported by a bent under each shoe consisting of a 12-in. I-beam of 14-ft. span resting on timber posts. After the new abutment was completed, the weight of the span was transferred to two 10 x 24-in. timbers, one under each shoe, bearing directly on the new concrete. This support remained in place until the old steel was removed.



CENTER SHOES BORE ON COMMON POST

The east span and the west span of the new bridge were concreted under the floor of the old bridge, there being 4 in. clearance between the top of the arch rings and the lower chord of the old steel. During the construction of the new center arch, however, it was necessary to support the inside ends of the two steel spans. The pins of the shoes of these spans were 2 ft. 11 in. apart. Three railroad rails were placed under the pins as a supporting span to reduce the area occupied by the temporary support, so that the opening which had to be left in the arch ring could be made as small as possible. The shoes were first supported on timber bents while the old span was removed, and then on 12 x 24-in. columns directly supporting the rails, as shown in one of the photographs. After the new arch had been concreted and the old steel removed, these holes were filled. The Widell Co., of Mankato, Minn., was the contractor. The new bridge was designed by the Iowa State Highway Department.



CONCRETE AND EARTH FILL PLACED FROM OLD SPANS SUPPORTED DURING CONSTRUCTIOIN OF NEW ARCH BRIDGE BENEATH

Table Shows Complete Average Operating Costs of Trucks

By Ralph W. Horne
Boston, Mass.

IT IS OFTEN the case that a prospective purchaser of a motor truck is misled in regard to the operating cost of the vehicle which he considers buying by a truck salesman who either wilfully or otherwise quotes costs that do not take into account certain items with which the purchaser soon finds himself confronted. During the past few years the writer has made it a point to collect data on the cost of motor-truck operation. These cover the operation of trucks during the periods of from one to several years, and it is believed that all factors which might be affected by seasonal variations are properly averaged.

In considering the distribution of cost, the total should be subdivided into separate, independent items so that each of these may be studied by itself and its relation to the whole cost determined. The following classification of costs will prove to be satisfactory:

1. Gasoline—More or less independent of the total mileage and not to be reduced by increasing the total ton-mileage.

2. Lubricants—A small item relatively and, like No. 1, constant regardless of the total ton-mileage.

3. Tires—Dependent upon the mileage and the load. This figure may be accurately determined only when data are available for some considerable mileage, and should include not only the first cost but any repair charges on the tires.

4. Repairs and Sundries—A large item and not decreased by large total ton-mileage.

5. Depreciation—Frequently neglected, and complicated in that sinking funds to care for the depreciation are calculated for a unit time, whereas the depreciation of a vehicle is dependent directly upon the mileage it accomplishes.

6. Chauffeur—A fixed quantity for any given period, the cost per ton-mile varying indirectly with the total of mileage.

7. License, Insurance and Taxes—A fixed amount regardless of ton-mileage covered by the vehicle, so that its cost per ton-mile is indirectly proportional to the total ton-mileage.

8. Storage—Independent of the mileage and thus also reduced as the total mileage increases.

9. Interest on Total Initial Investment—This might be figured at the rate of 5.5% per annum.

All of the foregoing items may be grouped into two classes. The first classification contains items 1, 2, 3, 4 and 5, which are found to be more or less constant regardless of the total ton-mileage; while items 6, 7, 8 and 9 are seen to fall under the second class, wherein all items decrease directly as the total ton-mileage increases, so that it is very desirable that as large a total as possible should be accomplished in a given period of time. With these figures it is possible to study the relation which each of the individual items bears to the whole if the total cost per ton-mile is obtained.

The accompanying table expresses the percentages which any given item is of the total item. They are based on a cost of 25c. per gallon for gasoline, taxes at $18 per $1000, license fees on the basis adopted by the Massachusetts Highway Commission, storage charges at the rate of $20 per month, and depreciation costs on the sinking-fund basis with interest at 5.5% applied annually. The life of the truck has been rationally estimated after careful study of the conditions under which the given truck was operating. Allowance must be made for any factors which may tend to increase or decrease the items, such as poor vs. good roads, hilly vs. level country, short vs. long haul, light vs. heavy loads, and short loading vs. long loading periods. An allowance likewise should be made where the costs of fuel, supplies and labor differ greatly.

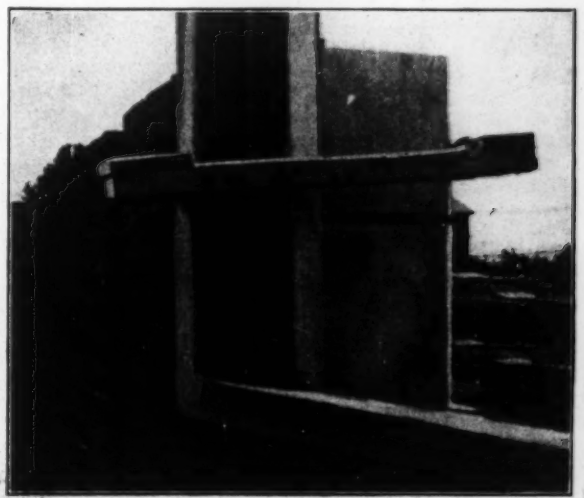
OPERATING COSTS OF MOTOR TRUCKS

Capacity of truck, tons	2	3	3½	4	5	7
Average load carried, tons	2	3 3	3 8	4 15	5 2	6 5
Total operating cost, cents per ton-mile	21 5	19 0	18 1	17 8	16 5	15 0
Per cent of total cost per ton-mile of cost of:						
1 Gasoline	13 6	15 2	17 3	19 7	18 6	17 0
2 Lubricants	4 7	4 2	2 0	1 4	2 2	2 2
3 Tires	18 0	14 8	13 5	10 8	16 7	20 2
4 Repairs and sundries	9 1	9 4	10 0	10 5	11 0	11 1
5 Depreciation	23 5	22 0	20 5	21 0	20 0	20 0
6 Chauffeur	18 1	20 6	24 0	21 7	17 5	15 4
7 License, insurance and taxes	4 3	4 4	4 6	5 4	5 0	4 8
8 Storage	5 2	4 8	3 0	3 6	3 7	4 0
9 Interest (at 5½% per annum)	3 5	4 6	5 1	5 9	5 5	5 3

Window-Frame Clamp Saves Time and Room

By John E. Langley
Huntington, W. Va.

WHEN setting window frames in stone or terra cotta faced buildings, considerable time can be saved, as well as avoiding the obstruction of floor space with long braces, by using the clamp shown in the photograph. The long piece is a 2 x 4 to each end of which is nailed at right angles a piece of board about 6 in. long. Five nails are used in each end. The distance between the inside edges of these boards is 1 in.



CLAMP CAN BE QUICKLY ADJUSTED

greater than the distance between the outer face of the jamb and the face of the brick backing.

The window frame is set up when the first jamb stones have been placed, after which one of the braces is placed at each side. The braces may be tightened with wedges, or by driving down one side until the brace sets tight. They will hold the window frame securely in place until the brick work is finished.

NEWS OF THE WEEK

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Hoisting of Suspended Span in Progress at Quebec

Began Monday and Proceeding Favorably at Rate of Nearly 50 Ft. per Day—Completion Expected Friday

Hoisting the new 640-ft. suspended span of the Quebec Bridge to its permanent position between the ends of the cantilever arms was begun on Monday, Sept. 17, 1917. The span replaces the one which fell into the St. Lawrence River during the attempt to hoist it, on Sept. 11, 1916, on account of breakage of one of the supporting rocker shoes of cast steel. During the year a new span has been built, identical with the first one, and at the same site, Sillery Cove. The same method of floating it to the bridge site was followed, and in a general way but with some changed details the same method of hoisting is being used. The work is in progress as we go to press, and is expected to reach completion on Thursday, Sept. 20, or early Friday.

The start of hoisting had been tentatively scheduled for Saturday, Sept. 15. But rising wind the evening before and reports of an approaching gale caused postponement to Monday. At sunrise, with perfect weather, the span was floated out from its erection sup-

Continued on page 571

New England Water-Works Men Get Together

Convention Held in Home City of President Saville, Who Is Awarded Brackett Medal for Best Paper in 1916

War times may have kept some from going to Hartford last week for the 36th annual convention of the New England Water-Works Association, but it did not interfere with the get-together spirit of the 150 active and 100 associate members and the 150 to 200 guests who received their blue, red or white badges at the registration desk.

By way of innovation, the convention opened a day earlier than usual, or on Tuesday instead of Wednesday. This gave opportunity for greetings from city officials and other prominent citizens of Hartford on Tuesday afternoon and for an informal reception the following evening. At the afternoon session Caleb Mills Saville, chief engineer and manager of the Hartford water-works, responded to the official and citizen welcome already mentioned and gave a brief address devoted to the interests of the association and its members. An abstract of the address appears on page 540 of this issue.

A particularly happy incident of the convention was the award to President Saville of the Dexter Brackett medal for the most meritorious paper appearing in the association *Journal* during 1916. The paper on which the award was based was entitled "Some Water-Works Experiences in Hartford, Conn.," read Nov. 10, 1915, and published in the *Journal* for June, 1916.

Some twenty papers were scheduled and nearly every author responded when his name was called. The program went through like clockwork, with ample time for discussion, and without wearisomely protracted sessions. Strictly speaking, there was little discussion. What did happen was the asking of scores of questions from the floor in order to elicit further information from the authors of papers.

A notable feature of the program was a group of seven papers on the Hartford water-works by members of President Saville's engineering staff. These came Thursday forenoon and prepared the way for a more thorough appreciation of the enjoyable automobile trip over the water-works, to which Friday morning was devoted. The seven papers mentioned included a historical and descriptive review of the works, by W. E. Johnson; outline of distribution system, by Frank Brainard; engineer-

SUSPENDED SPAN OF QUEBEC BRIDGE JUST BEFORE IT WAS FLOATED TO PLACE AND RAISED THIS WEEK

ing work on additional gravity supply, by H. W. Horne; design of spillway at Richard's Corner dam, by R. E. Wise; construction of Phelp's Brook dam, by J. H. Shaunessy; construction of Nepaug River masonry dam, by H. W. Griswold; and grouting dam foundations, by J. E. Garrett.

Water Filtration Given Entire Session

A feature of the well-devised program was an entire session devoted to filtration, with three papers on rapid or mechanical and one on slow sand filters. The session was led off by George A. Johnson, consulting engineer, New York City, who presented an extended review of "Rapid Sand Filtration," sufficient to fill a whole number of the *Journal* of the association. How far rapid filters exceed slow sand filters in numbers and population supplied is shown by extracts from Mr. Johnson's paper, on page 542. The paper also showed the striking decline of typhoid since water filtration was well established in this country, went into details of rapid filters, and discussed pretreatment and after-treatment of water subjected to either of the two types of filtration.

Robert Spurr Weston read a paper on "Mechanical Filter Bottoms and Strainer Systems," abstracted on page 543.

Mechanical filtration at Evanston, Ill., was described in a paper sent by John W. Gaitenby, superintendent of filtration. After experience with both kinds, Mr. Gaitenby does not think high-velocity filter washing with water alone is any better than air-and-water wash. The wash-water velocity at Evanston is 15 ft. per second. The operation of the slow sand filters at Providence, R. I., was described by F. L. Cady, bacteriologist, Providence Water Department.

Some Questions Answered

In answer to a question following Mr. Johnson's paper the author said that after filtered water becomes available, flushing through hydrants is generally all that is necessary to get rid of possible contamination in the mains. E. E. Lochridge, Springfield, Mass., said that when filtered water was introduced in that city a reversal of the direction of flow was caused. A bushel or two of sediment per hydrant was flushed out.

Answering another question, Mr. Johnson said that wash water at the Baltimore rapid filters is conserved by discharging it into a settling pond. W. C. Hawley stated that at Wilkinsburg, Penn., sedimentation and reuse reduces the wash water to 0.1%—a matter of moment, since some of the supply is pumped against a total head of 630 feet.

Water Rates and Allied Matters

Problems connected with the regulation of the private companies supplying water to portions of New York City were reviewed at some length by Delos F. Wilcox, deputy water commissioner. In the case of one company, the city effected an increase in hydrant rental at public expense to gain a needed reduction in rates to private consumers. The city now has a large surplus gravity supply on hand, from the Catskill system, which would naturally be used in place of water now pumped from wells by private companies, and might be furnished at lower rates than the companies are charging.

How Waltham, Mass., voluntarily revised its water rates in accordance with the general plan adopted by state public service commissions was told by Bertram Brewer, city engineer and superintendent of sewers and waterworks. Reproduction cost was estimated, the expenses of the past five years reviewed, the needs of the future forecast and new rates fixed accordingly. An annual surplus of $8000 having been produced by unexpected economies, due to improved city administration, further revision is proposed, with reference to doing away with conditions particularly annoying to consumers. Mr. Brewer believes that a municipal water-works plant should pay taxes into the public treasury and should, in turn, be paid for all service it renders other municipal departments.

Various Practical Experience Papers

A combined repair and service shop, costing $29,000 with land and equipment, was described by H. W. Hosford, water commissioner, Northampton, Mass. The building is about 40 x 120 ft. in ground plan. Part of it is two stories high. Provision is made for ordinary repair work, meter testing and storage of supplies. There is a garage.

Experiences in laying 48,000 ft. of 4-, 6- and 8-in. universal joint pipe, beginning in 1908, were described by John H. Walsh, superintendent, water-works, East Hartford, Conn. No repairs due to the pipe itself have been necessary. Another member, who had laid 25,000 ft. of this pipe since 1911 with good results, stated that elastic paint seemed to be better than white lead at the joints.

A variety of interesting problems met and solved at Windsor, Conn., were detailed by H. R. Turner, superintendent of water-works. His experiences with Leadite for joints are presented on page 544.

How 69 master meters of the venturi type and a steadily increasing number of service meters are reducing water consumption in the Massachusetts Metropolitan Water District was told by S. E. Killam, superintendent of pipe lines and reservoirs. An abstract of this paper is given on page 541.

The use of copper sulphate to control microscopic organisms causing bad tastes and odors in water was dealt with by William Haine, of the Newlands Sanitary Laboratory. J. L. Jackson, one of the engineering members of the Advisory Council of the Connecticut Department of Health, reviewed some stream-pollution problems in the state.

The customary exhibit of water-works appliances was well staged by William F. Woodburn, of the Warren Foundry and Machine Co. The Water-Works Manufacturers' Association provided funds for whist and theater parties for the ladies. The Hartford Water Board took the members and guests on an automobile trip to its water-supply sources and provided lunch at the Hartford Golf Club. Other courtesies were extended by the Pratt & Cady Co. and the Terry Steam Turbine Works, of Hartford, and C. W. Blakeslee & Sons, contractors for the Richards' Corner dam.

Quebec Bridge Raising

Continued from page 570

ports, using the same scows that did the work a year ago. It reached the bridge site and was moored to the hanging mooring-trusses by 7:30. The four chairs under the ends of the span were attached to the eyebar lifting-chains, and at 9:30 jacking was begun, raising the span clear of the scows in an hour. By 4:40 p.m. twelve 2-ft. lifts had been made, and then work was stopped for the night, the span being first anchored against wind. Last year's program contemplated continuous work until the span was up in its permanent position, which it was believed could be accomplished within 24 hours. This year no nightwork is being done.

Jacking was resumed at 7 a.m. Tuesday and except for the noon-hour interruption continued till 5:30 p.m., 22 more lifts being made, a total from the start of 34, or 68 ft. of lift. The work was not hurried, and it was interrupted from time to time to remove the freed links of the lifting chains.

Judging from the rate of progress attained Tuesday, at least two more days were then required to finish the hoisting. The final steps, including attachment of the permanent hangers, may carry the work over to Friday.

Association of Engineers Organizes Three New Chapters

The board of directors of the American Association of Engineers, at their meeting on Sept. 5, granted charters to the members in St. Paul, Indianapolis and Milwaukee. This makes a total of seven chapters which have been organized since the association was incorporated about two years ago. The total enrollment is now over 2200.

A joint meeting of the association and the Detroit Engineering Society was held in the Commerce Building, Aug. 30. It was the unanimous opinion of the engineers present that the Detroit society should form a working cooperation with the American Association, as they have been carrying out a similar program locally for Detroit as the other organization has operated in a national way. The Detroit society has a total enrollment of about 700 members, and if this working coöperation is established it will mean the furthering of the work laid out by the Committee on Engineering Coöperation.

Should Exemption for Medical Students Apply to Engineers?

In view of the suggestion that students in engineering colleges be exempted from draft in the National Army, the following memorandum from the provost marshal general to the governors of all states, exempting medical students and hospital internes, is timely:

"The President prescribes the following supplemental regulations governing the execution of the selective-service law:

"First—Hospital internes who are graduates of well-recognized medical schools, or medical students in their fourth, third or second year in any well-recognized medical school who have not been called by a local board may enlist in the Enlisted Reserve Corps provided for by Section 55 of the National Defense Act under regulations to be issued by the surgeon general, and if they are thereafter called by a local board they may be discharged on proper claim presented on the ground that they are in the military service of the United States.

MAY APPLY FOR DISCHARGE

"Second—A hospital interne who is a graduate of a well-recognized medical school, or a medical student in his fourth, third or second year in any well-recognized medical school, who has been called by a local board and physically examined and accepted and by or in behalf of whom no claim for exemption or discharge is pending, and who has not been ordered to military duty, may apply to the surgeon general of the Army to be ordered to report at once to a local board for military duty, and thus be inducted into the military service of the United States, immediately thereupon to be discharged from the National Army for the purpose of enlisting in the Enlisted Reserve Corps of the Medical Department. With every such request must be enclosed a copy of the order of the local board calling him to report for physical examination (Form 103), affidavit evidence of the status of the applicant as a medical student or interne, and an engagement to enlist in the Enlisted Reserve Corps of the Medical Department.

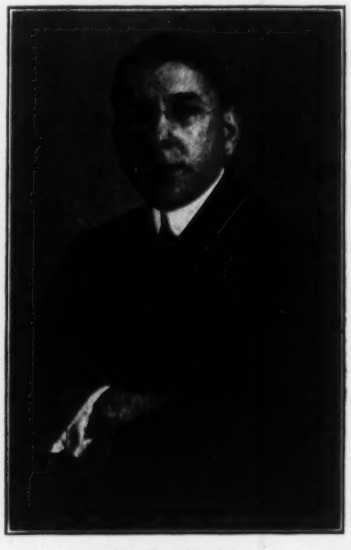
WILL NOT BE SENT TO CAMP

"Upon receipt of such application with the named enclosures the surgeon general will forward the case to the adjutant general with his recommendations. Thereupon the adjutant general may issue an order to such interne or medical student to report to his local board for military duty on a specified date, in person or by mail or telegraph, as seems most desirable. This order may issue regardless of the person's order of liability for military service. From and after the date so specified, such person shall be in the military service of the United States. He shall not be sent by the local board to a mobilization camp, but shall remain awaiting the orders of the adjutant general of the Army. The adjutant general may forthwith issue an order discharging such person from the military service for the convenience of the Government.

"Three official copies of the discharge order should be sent at once by the adjutant general to the local board. Upon receipt of these orders the local board should enter the name of the man discharged on Form 164A and forward Form 164A, together with two of the certified copies of the order of discharge, to the mobilization camp to which it furnishes men. The authorities at the mobilization camp will make the necessary entries to complete Form 164A, and will thereupon give the local board credit on its net quota for one drafted man."

H. E. Hilts General Manager of Portland Cement Association

H. E. Hilts, formerly district engineer at San Francisco for the Portland Cement Association, has been elected by



H. E. HILTS

the board of directors of that body to succeed the late J. P. Beck as general manager.

Mr. Hilts was born in New York in 1882 and obtained his technical and engineering education at the University of Pennsylvania, where he graduated in 1905. His first work was as rodman with the Mexican International R.R. Later he was in the employ of the Philadelphia & Western R.R. For two years he was instructor in the engineering department of the University of Pennsylvania, after which he entered the service of the New York Central R.R., leaving that company to become associated with the Portland Cement Association as road engineer in 1913, for territory comprising the New England and Northeastern States, having been stationed at Albany and Easton, Penn. In 1915 he was appointed district engineer at San Francisco.

While with the New York Central R.R. Mr. Hilts designed reinforced-concrete arches carrying the railroad over city streets, worked up schemes for accommodating increased traffic at the Weehawken yards of the West Shore R.R., made investigations of grain elevators in and near Buffalo, designed masonry abutments and piers for various crossings over the New York State Barge Canal. Among other works upon which Mr. Hilts was engaged was the design of five reinforced-concrete bridges at Rome, N. Y., and a four-track tunnel at Rhinecliff, New York.

Mr. Hilts is an associate member of the American Society of Civil Engineers, member of the American Society for Testing Materials, associate member of the American Railway Engineering Association and member of the American Concrete Institute.

Help Re-Make the World!

The following advertisement appeared in the *New York Times* of Sept. 13:

"Help Re-Make the World

"The call of the time is for the engineer or applied scientists, including the physician and sanitarian. Young men who are ineligible for military service for one reason or another, or who can render better service by completing their technical courses, should train themselves to become builders of the future.

"Vast parts of Europe are in ruins. Our own railroads and industrial equipments will need rebuilding after the terrible strain of wartime. Yet the supply of technically trained men does not meet the demand *now*. When the war is over the demand will be still greater.

"America must take a leading part in the reconstruction of the world. Products of our factories, farms and mines, raw materials and finished products will be needed in enormous quantities. Physicians and sanitarians must be supplied to aid the wounded and to restore sanitation.

"War is not only fought at the front. And if you cannot serve there you should train yourself technically to direct production of clothing, chemicals, food, munitions and machinery of war. And then in the days of reconstruction to come you can help to repair the ravages of war.

"Men who hold the helm of the Ship of State voice this appeal. Let them convince you that if adapted for applied science you are urgently needed in that field. Read and heed their words. Do not allow the supply of trained engineers, chemists, biologists, agriculturists and physicians to be depleted. Enter or continue in a technical school if qualified for such a career. You will thereby be performing a patriotic duty and will help the industrial progress of America and of the world.

"Brooklyn Polytechnic Institute, Brown University, Carnegie Institute of Technology, Case School of Applied Science, Clarkson College of Tech-

nology, University of Colorado, Thayer School Civil Engineering, Dartmouth; Drexel Institute, George Washington University, Harvard University, University of Illinois, Johns Hopkins University, Lafayette College, Lehigh University, Leland Stanford Jr. University, Massachusetts Institute of Technology, University of Michigan, Michigan Agricultural College, Michigan College of Mines, Missouri School of Mines, University of Missouri, New York University, Towne Scientific School, University of Pennsylvania; Princeton University, Rensselaer Polytechnic Institute, Rose Polytechnic Institute, Rutgers College, Sheffield Scientific School, Yale; University of South Dakota, Stevens Institute of Technology, Syracuse University, University of Texas, Tufts College, University of Vermont, University of Virginia, Washington University, St. Louis, Mo.; University of Wisconsin, Worcester Polytechnic Institute."

Washington Association of County Engineers Convene

The Washington State Association of County Engineers, in which 39 counties are represented, held their thirteenth annual convention at Spokane, Wash., Sept. 6, 7 and 8. As usual the meeting was held at the same time and place as the convention of county commissioners of the State of Washington. The papers read before the engineering sessions included "The Preparation of Preliminary Estimates," by H. J. Doolittle, division engineer, Washington State Highway Department, Spokane; "Small Bridges and Culverts," by M. K. Snyder, professor of structural engineering, State College of Washington, Pullman; "The Location of the Wenatchee-Ellensburg Road," by J. W. Miller, assistant professor of civil engineering, University of Washington, Seattle; "Concrete Roads of Washington," by C. N. Reitze, consulting engineer, Seattle; "The Use of Bitumens in Road Construction and Maintenance," by Allen R. Scott, county engineer, Spokane County, Spokane.

R. H. Thomson, former city engineer, of Seattle, reviewed the recent progress of civilization in its relation to road building and discussed the developments which may be looked for along this line. State and county funds must not be looked upon as the source from which all road moneys must come, he said. We must get accustomed to the idea of local assessments. Mr. Thomson made two suggestions to the association with the comment that the organization would do well to take some action upon them. These were (1) that in the Northwest, where roads are built through lowlands, several years should elapse after grading and draining is done before the hard surfacing is put on, and that it is the duty of engineers to see that this need is observed even if it is necessary to change the state constitution to accomplish it; and (2) that officials in the universities at Pullman and Seattle be authorized and instructed to try out various types of road-working machinery to the end that specific recommendations be published for the benefit of county engineers as to the best equipment adapted for certain work with materials commonly used on roads in the state. These suggestions were enthusiastically endorsed by the convention.

Seattle was selected for the meeting place in 1918 and the following officers were elected for the ensuing year: President, G. G. Harvey, county engineer, Lincoln County; first vice president, R. F. Foster, county engineer, Douglas County; second vice president, D. H. White, county engineer, Pierce County; secretary-treasurer, C. A. Lindberry, county engineer, Whatcom County.

Norwegian-American Engineers To Meet in Chicago

American and Canadian engineers and architects of Norwegian birth and descent are to hold an informal meeting and reunion in Chicago, Sept. 27 to 29. The meetings will be at the Chicago Norske Klub. Joachim G. Giaver, consulting engineer, is chairman of the committee of arrangements. Visits will be made to the underground freight railway system, the drainage canal and other points of interest.

Navy Department Wants Assistant Civil Engineers

An examination will be held at the Navy Department, Washington, D. C., to fill not less than 10 existing vacancies in the grade of assistant civil engineer, Corps of Civil Engineers, United States Navy.

The examination to determine the candidate's professional fitness will comprise:

1. A preliminary examination to determine the candidate's general fitness, based on his collegiate record, testimonials, statements of references and professional experience. Candidates will not be assembled for this examination, but will submit their papers by mail direct to the examining board in Washington.

2. A final examination, including an oral and written examination, to be held in Washington, D. C., and open only to those who have passed the preliminary examination.

Candidates before the final examination will be examined as to physical fitness by a board of medical officers of the United States Navy. If found to be physically unfit the candidate will not be further examined.

The following are prerequisites for consideration:

No candidate over 26 years of age on July 1, 1917, will be eligible for examination. The candidate must be an American citizen, must have received a degree from a college or university of recognized standing, showing that he has satisfactorily completed a course in civil, electrical or mechanical engineering; must have had not less than 14 months' practical professional experience since graduation, and must be of good moral character and repute.

Candidates who did not qualify in the preliminary examination held in May, 1917, or who failed in the final examination held in June, 1917, are not eligible for this examination. Candidates who passed the preliminary examination but failed to complete the final examination are eligible for this examination.

The fact that a man is married will not militate against his eligibility for the examination.

Appointees are commissioned in the grade of assistant civil engineer, Corps of Civil Engineers of the Navy, with the rank of lieutenant (junior grade). This rank carries with it pay and allowances approximating $2500 a year. The highest rank in the Corps of Civil Engineers is rear admiral, carrying with it, including pay and allowances, a remuneration of approximately $9500 a year.

A descriptive circular regarding the Corps of Civil Engineers, United States Navy, and the coming examination for assistant civil engineer will be mailed to those interested upon request to the chief of Bureau of Yards and Docks, Navy Department, Washington, District of Columbia.

Holds That Jersey City Cannot Reopen Water Suit

Jersey City has no legal grounds for an application to reopen the lawsuit in which the Court of Chancery and the Court of Errors and Appeals held that the hypochlorite plant at Boonton fulfilled the contract of the Jersey City Water-Supply Co. to furnish pure and wholesome water, says Marshall A. Von Winkle, special counsel, in an opinion submitted to the Jersey City Commission. Mr. Von Winkle holds that newly discovered evidence, in existence when the case was tried, would be necessary to reopen the case, and that none such exists.

Even though the Court of Chancery did make a mistake in its decision, and the mistake was confirmed by the Court of Errors and Appeals, says Mr. Von Winkle, there is now no relief. The object of reopening the suit would be to compel the contractor to build a trunk sewer through the Rockaway Valley to divert sewage (when sewer systems are built) to a point below the Boonton dam. The court decision of 1908 held that the chlorination plant made such a sewer unnecessary—or relieved the contractor of any obligation to build one. Jersey City has applied to the State Department of Health for approval of plans for a trunk sewer, as stated on page 522 of our issue of Aug. 13, 1917.

PERSONAL NOTES

R. V. ROSENBAUM, formerly resident engineer with the Kanawha Traction and Electric Co., of Parkersburg, W. Va., is now resident engineer and superintendent of construction for the Potomac Light and Power Co., engaged in building a hydro-electric station at Dam No. 5 on the Potomac River near Martinsburg, West Virginia.

J. A. WADE, until recently assistant to the chief engineer on the construction of the munitions plant of the British Chemical Co., at Trenton, Ont., is now resident engineer for Esselstyn Murphy & Hanford, Detroit, on the construction of a steam power plant for the Central Michigan Light and Power Co., at Alma, Mich. Mr. Wade has been connected with the Morgan Smith Co., of York, Penn., designing water-power machinery and water-power plants, and later was in the office of George F. Hardy, New York City, on paper-mill design.

JOHN R. MONAGHAN, who for the past 10 years has been in various positions with the engineering department of the Public Service Commission, New York City, has resigned to take the position as engineer for subway construction with the Rapid Transit Subway Construction Co., New York City.

FRANK MCLAUGHLIN has resigned as contracting manager with the Federal Bridge and Structural Co., of Waukeshaw, Wis. He has accepted a position as chief engineer of the Kelly-Atkinson Construction Co., of Chicago, and has charge of the construction of 18 single-screw composite cargo-carrying steamers which this company is building for the United State Shipping Board, Emergency Fleet Corporation, at Mobile, Alabama.

J. K. MACNEILLIE, general superintendent of the Canadian Government Ry., has resigned to accept a position on the Delaware & Hudson Ry. under F. P. GUTELIUS, former manager of the Canadian Government Ry. L. S. BROWN, assistant general superintendent, becomes general superintendent of these roads.

JESSE A. JACKSON has been granted an indefinite leave of absence from his position as chief road computer in the engineering department of the City of Seattle, to fulfill his duties as major, Signal Corps, United States Army.

GEORGE B. POST & SONS and ERNEST P. GOODRICH announce that they have become associated professionally in the practice of architecture, engineering and city planning. The new firm comprises the following men: WILLIAM S. POST, J. OTIS POST, GEORGE B. FORD, ERNEST D. GOODRICH and A. PEARSON HOOVER, and will have an architectural office at 101 Park Ave., New York City, and an office at which engineering matters will be handled at 261 Broadway, New York.

F. J. VON ZUBEN, city engineer of Fort Worth, Tex., is acting as supervising engineer on the construction of Camp Bowie. Mr. Von Zuben was incorrectly mentioned as being "Constructing Quartermaster" on p. 284, issue of Aug. 9.

JOHN L. BACON has been elected to the City Council of San Diego, Calif., as a result of an effort made by the business men of that city to promote a more efficient city government. The Council is now working on several schemes looking toward the divorcement of city government from personal favoritism.

L. T. KNISTERN, who was until recently superintendent of construction on the Thirty-ninth Street Power House, Chicago, Ill., is now superintendent of construction for the Chester Shipbuilding Co., Chester, Penn. Mr. Knistern was at one time assistant general superintendent for Thompson-Starrett Co., and during 1914 represented that company in Chili, S. A., returning at the outbreak of the present war to become superintendent of construction of the Equitable Building in New York City.

CHESTER W. SMITH, who for the past year has been connected with the J. H. Mendell Engineering and Construction Co., Manchester, N. H., on estimates and investigation for various hydro-electric projects, has been spending his time recently equipping a yard at Newington, N. H., for the building of wooden steamers under Government contract.

LE ROY K. SHERMAN has opened an office as consulting engineer at 5 North La Salle St., Chicago. He was formerly the engineer member of the Illinois Rivers and Lakes Commission, the duties of which are now included in one of the departments of the new state civil organization.

OBITUARY

CHARLES LEE CRANDALL, emeritus professor of railway engineering at Cornell University, died on Aug. 25, at Ithaca, N. Y., after a week's illness with penumonia. Practically all of Professor Candall's adult life was given over to Cornell University. In 1868, a boy of 18, he entered the first class of the university and graduated with the first full class in 1872. For two years thereafter he was engaged in railway engineering, but he returned to Cornell in 1874 as instructor in civil engineering, becoming professor of railway engineering and geodesy in 1895, and retiring as an emeritus professor in 1915. For four years, 1902-06, he was in charge of the College of Civil Engineering. In addition to his regular professorial duties, Professor Crandall found time to be city engineer of Ithaca for 20 years and to write a number of books on railway layout and construction and, in his earlier years, on descriptive geometry and drafting. He was a distinguished member of the American Railway Engineering Association, contributing much to the committee work of that society, particularly to the committee on iron and steel structures. As collator of the biographical data of the graduates of his college he kept in touch, as few professors can, with the graduates of the college.

GEORGE S. RIDER, head of the George S. Rider Co., of Cleveland, died suddenly at his home, Sept. 11, as he was about to leave for his office. A heart attack was held the cause. Mr. Rider went to Cleveland from Providence, R. I., 25 years ago, and started in business as a consulting engineer. He designed several of the largest industrial plants in Ohio. He was a member of the Cleveland Chamber of Commerce, Cleveland Engineering Society, American Society of Mechanical Engineers and Franklin Institute.

J. H. P. HUGHART, president of the Grand Rapids & Indiana Ry., died Aug. 16 in his home in Grand Rapids, Mich., from concussion of the spine caused by a recent fall. Mr. Hughart was born in Pittsburgh, Penn., and received his education at the Massachusetts Institute of Technology. Entering the employment of the Grand Rapids & Indiana Railway Co. in 1874, he became second vice president in 1892, vice president and general manager in 1906, and president in 1914—which last position he held at the time of his death.

HARRY A. DALLYN, of St. Thomas, Ont., consulting engineer with the Ontario Hydro-Electric Power Commission, was electrocuted while at work on a new system at Sarnia.

WILLIAM HARRY ARNOLD, terminal engineer of the Lehigh Valley Railroad Co. at New York, died Aug. 13, 1917. At the time of his death Mr. Arnold had charge of the new ore dock at Constable, N. J., together with the construction of piers, pier sheds and dredging in New York harbor and Perth Amboy, N. J. Graduating from the Rensselaer Polytechnic Institute in 1890, Mr. Arnold was with Nier & Hartford, and then with Hartford & Hebert, engineers, Chattanooga, Tenn., on general engineering work. For four years with G. W. G. Ferris & Co., Pittsburgh, Penn., on general inspection work, he then became connected with the Barber Asphalt Paving Co., of Buffalo, and then with R. W. Hildreth & Co., New York, on inspection work in the vicinity of New York. From 1896 to 1899 he was with various offices of the Corps of Engineers, U. S. A., as draftsman, inspector of harbor im-

Engineer Officers' Reserve Corps Assignments

The following-named officers of the Engineer Officers' Reserve Corps now on duty at the engineer training camp, in the vicinity of Washington, D. C., are relieved from duty at that place and will report at the proper time at the divisional training camps indicated below for duty with the engineer regiments and engineer trains of the National Army at those places:

To Wrightstown, N. J.

Majs. H. B. Brewster, S. S. Garrett; First Lieuts. Jamieson Marshall, Robert L. Tate, Theodore S. Babcock, George P. Kuzmier, Gilbert Doolittle, David M. Dunning, Harry H. Walsh, Allen W. Jacus, Bevan Jones, Leonard H. M. Whitney, Ray McL. Robinson and Merl B. Breese; Second Lieuts. Frederick H. Gross, Butler E. Ward, Manly L. Mackey, Peter E. Bermel, Allen Mulford and George L. Beaver.

To be attached to the Three Hundred and Third Engineers, Wrightstown, N. J.: First Lieuts. Harold L. Hock, Raymond C. Semple, Louis E. Thompson, Alexander Kennedy, Jr., Laurence Knibloc, Ashton H. Hart, Frank S. Storey, Harold Govinlock, William B. Neilson, Jr., George W. Knight and Francis H. Wisewell, Jr.; Second Lieuts. Aldace H. Davison, Henry TenHagen, Howard E. Bailey, Virgil D. Stone, George E. May, Gerald F. Healy and David H. Cameron.

For assignment to the Three Hundred and Third Engineer train, Wrightstown, N. J.: Capt. Earle H. Welles, First Lieuts. George N. Brown and Clarence C. Bailey, Second Lieut. Kerr Atkinson.

To be attached to the Three Hundred and Third Engineer train, Wrightstown, N. J.: Second Lieuts. William B. Clarkson and Earl B. Miller.

To Annapolis Junction, Md.

For assignment to the Three Hundred and Fourth Engineers, Annapolis Junction, Md.: Majs. James F. Barber and Percival M. Churchill; Capts. Percy J. Wilson, Lewis P. Bailey, Alexander Colt, Erastus St. John, Henry Taylor, Theodore S. Dunn, Frank W. Hamilton, Samuel H. Brooks and Leon R. Woodhull; First Lieuts. Harry L. Haverstick, Gordon H. Fernald, John R. Armington, Meyer Hefstater, John D. Brewster, James H. Smith, Jr., James M. Roberts, David A. Gilbert, Edgar C. Rack, Spencer Roberts, Daniel Summers and John P. Fogarty, Jr.; Second Lieuts. Otis D. Covell, Albert S. Crandon, Francis E. Schenker, Earl W. McKee and Richard C. Greenland.

To be attached to the Three Hundred and Fourth Engineers, Annapolis Junction, Md.: First Lieuts. Frank T. Leilich and Howard C. Molsberry; Second Lieuts. Howard A. Thompson, Bernard E. O'Hagan, Francis S. Friel.

Further assignments will be noted in next week's issue.

---

provements and on work in connection with battery emplacements at Fort Wadsworth, N. Y., and Fort Taylor, Key West, Fla. From 1899 to 1903 he was superintendent and engineer for the W. H. Beard Dredging Co., New York, with complete charge of the dredging fleet and reconstruction of dredges and tugs. For a year he was connected with various harbor improvements in New York and in the Philippine Islands, becoming in 1905 superintendent of floating equipment for the Bush Terminal Co., of New York City, and in 1906 being made chief engineer for the same company. In 1907 he established the firm of Arnold & Andrew, consulting engineers, New York City, and then in 1909 became general manager of the Bay State Dredging Co., Boston, Mass. From 1912 to 1914 he was engaged in general engineering work, and at the latter date became terminal engineer of the Lehigh Valley.

LIEUT. H. W. MORRIS, who before his enlistment in the 73rd (Canadian) Highland Battalion, was chief electrical engineer of the Grand Trunk Ry., has been reported killed in action. Lieutenant Morris had been awarded the military cross for distinguished bravery at La Culotte on June 12 of this year.

J. W. WATTS, honorary treasurer of the Royal Architectural Institute of Canada since its inception, died very suddenly at his home in Ottawa.

ALEXANDER MITCHELL, for over 50 years one of the leading contractors of Toronto, Ont., died at his home there recently.

BUSINESS NEWS

Hudson River Brick Shows Increase in Value

The supply of common building brick for the enormous consumption of Greater New York, the largest brick market in the United States, comes principally from the narrow strip of land on either side of the Hudson from New York City to Cohoes, including Bergen County, New Jersey. In 1916 the number of brick marketed in this region, according to a report in preparation by the United States Geological Survey, Department of the Interior, was 893,552,000, a decrease of 66,975,000 brick. The value of this output, however, was $5,915,254, an increase of $906,189 over 1915. The average price per 1000 brick was $6.62, an increase of $1.41 over 1915.

The New York part of the region is by far the larger producer, reporting, for 1916, 702,596,000 brick, or 79% of the total, valued at $4,552,468, or 77% of the total for the region. This was a decrease of 38,972,000 brick, but an increase of $807,920 compared with 1915. The average price per thousand in this part of the region increased $1.43, or to $6.48. Ulster was the leading county in this part of the region, reporting 222,651,000 brick, valued at $1,444,275, a decerase of 6,692,000 brick but an increase of $333,783 in value, compared with 1915.

The New Jersey part of the region reported 190,956,000 brick, valued at $1,362,786, being a decrease of 28,003,000 brick, but an increase of $98,269.

After-War Lumber Demand

While world peace still seems far off, the Southern pine industry, according to J. E. Rhodes, secretary of the Southern Pine Association, is already making preparations for the part it will play in the work of rebuilding the devastated areas of Europe. The Federal Lumber Trade Commission, financed jointly by the Government, the Southern Pine Association and other lumber organizations, is now abroad making a first-hand study of the probable requirements of the various allied nations when hostilities cease. It is the general opinion that, although Europe will not be prepared to buy or use much lumber the first year after the war, and material delivered will cost high prices, due to the scarcity of tonnage and consequent excessive ocean freight rates, the second year after peace will witness a considerable movement of Southern pine across the seas, and there will be a steadily increasing demand for some years afterward.

In order to take care of this business properly, the Southern Pine Association now has in process of formation a Foreign Export Selling Agency, which will have representatives in the various European centers, and deal directly with the European buying agencies, which all who have studied the problem feel certain will be organized by foreign powers.

Building Tile Manufacturers Form Association

The Hollow Building Tile Association has recently been organized, with a membership of 65 manufacturers, representing 2,200,000 tons of material. In percentage it is about 90% of the output of building tile, and the membership extends from the Atlantic Coast to Texas. The manufacturers of tile united in the organization of this association because they realized the very great need for a central body which would do for the industry the things that needed to be done and which could not be done by the individual manufacturer.

The use of all materials in the larger cities is controlled by law; one of the most important problems confronting this association is building codes. The association has established a building-code department and has employed John A. Ferguson, an engineer, to have charge of it. He will work with and coöperate with building committees and building inspectors in all cities and states

which are revising their codes. He will also try to have the code changed whenever it is unfair to tile material. The engineer in charge will also make investigations covering the fire-resistant qualities of tile material, to see that it is properly recognized by the underwriters and insurance companies.

Notes from

MAKERS OF PLANT AND EQUIPMENT

Gaston, Williams & Wigmore, Inc., international merchants, New York City, announce the resignation of Thomas S. Garrett as manager of their machinery department. Mr. Garrett is planning to go into business for himself.

José Más Nadal, formerly construction inspector with the Department of the Interior, Puerto Rico, wishes to secure agencies for construction material. His address is P. O. Box 30, Humacao, Puerto Rico.

The Topping Motor Truck and Machinery Co., Pittsburgh, dealer in general contractors' equipment, such as Koehring concrete mixers, McKiernan-Terry pile hammers, Gramm-Bernstein motor trucks, etc., announces the appointment of Otto Lehmann, Jr., as a member of the sales force.

The Asbestos Protected Metal Co., of Pittsburgh, announces the opening of a sales office in the Union Central Building, Cincinnati, under the direction of J. C. Lathrop.

The Buffalo Contractors' Plant Co., Buffalo, N. Y., has reorganized with the following officers: G. M. Misner, president; E. S. McCready, general manager; F. H. Williams, chief engineer; William Viess, assistant engineer; William Ahlers, production manager; F. B. Misner, purchasing agent; W. L. Misner, sales manager. The company will continue to specialize in its well-established lines of hoists (steam-electric), derrick fittings, hand powers.

Gen. T. C. du Pont has recently joined the directorate of the Vulcan Steel Products Co. Other new members on the Vulcan board of directors are Hon. Frank H. Hitchcock, who assumes the duties of vice president, and L. W. Baldwin, of the Empire Trust Company.

H. J. Richardson has been appointed works engineer for the Berger Manufacturing Co., Canton, Ohio. His new work includes the power plant, new constructions, maintenance and repair of manufacturing equipment and buildings. Mr. Richardson recently was connected with the New England Westinghouse Co., where he was manager of the gage department. Previous to this connection he was acting chief engineer of the ordnance department of the Crucible Steel Co., Harrison, N. J., and prior to that, for a long time he was with the Commonwealth Edison Co., of Chicago, the last seven years of this service having been in the engineering department.

TRADE PUBLICATIONS

The Sullivan Machinery Co., Chicago, Ill., has issued a new catalog on diamond core drills which contains data on prospecting with these drills.

The Jeffrey Manufacturing Co., Columbus, Ohio, is sending out Bulletin No. 229 describing the Jeffrey stepped multi-bladed fans for the ventilation of mines.

"Michigan" water pipe is described in a new catalog issued by the Michigan Pipe Co., Bay City, Mich. Arguments for the use of this pipe are stated in new form and illustrated with fresh views and sketches, besides which useful data for water-works are given.

Bulletin No. 221, listing offerings in rails, locomotives, cars, etc., and "Blue Streak Special," Bulletin No. 222, listing machinery offerings, have been received from the Walter A. Zelnicker Supply Co., St. Louis, Missouri.

The Fort Scott Cement Association, Kansas City, Mo., has issued a booklet illustrating the use of natural cement in a wide variety of structures.

The West Coast Lumbermen's Association, Seattle, Wash., is distributing copies of the revised standard specification grading and dressing rules covering Douglas fir car material. This is the result of the work of a special committee, appointed to revise the rules for the grading of car material so as to conform with changes made in the standard rules of Jan. 1, 1917.

The Western Electric Co., 195 Broadway, New York, has issued a new edition of its Year Book. This follows the plan of uniform list prices and basic discount inaugurated by this company three years ago, and in addition manufacturers' list prices are shown on certain standard lines. The book consists of 1160 pages and contains more than 50,000 items.

Folder describing the "Blaw" Bulldog bucket has been received from the Blaw-Knox Co., Pittsburgh, Pennsylvania.

The Buchanan all-steel rock and ore crusher, Type C, is described in Bulletin No. 10 issued by C. G. Buchanan Co., Inc., 90 West St., New York.

The Edison Storage Battery Co., Orange, N. J., has issued a new bulletin describing and illustrating Edison storage batteries in lumber transportations.

Worthington volute centrifugal pumps are described in Bulletin W-600-A received from the Worthington Pump and Machinery Corp., 115 Broadway, New York.

The C. F. Pease Co., 213 Institute Place, Chicago, has issued a drafting-room equipment pamphlet. The equipment includes horizontal and vertical filing cases, drawing tables, roller mounts for maps and charts, and such supplies as lettering triangles, punctators (for dotted lines), bottle holders and pen fillers.

The American Steel Export Co. has recently published a 16-page illustrated booklet describing the practice of American makers of tin plate.

The Jennison-Wright Co., Toledo, Ohio, has issued a pamphlet containing a report of comparative bleeding tests made on Kreolite lug and plain rectangular wood paving blocks made by Clyde T. Morris, professor of civil engineering, Ohio State University.

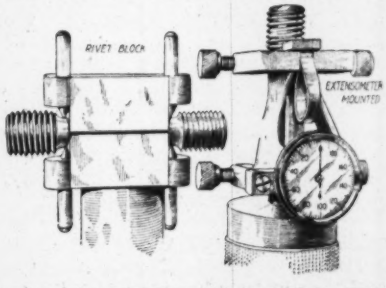
APPLIANCES AND MATERIALS

Yield Point Can Be Closely Determined by Simple Extensometer

A new extensometer has been brought out by the Riehlé Bros. Testing Machine Co., of Philadelphia, to meet the demand for a simple, direct-reading, compact and rigid instrument that can be quickly attached to a specimen, and by which the yield point may be more closely determined than by the drop-of-beam.

Provision is made for attaching the instrument to opposite sides of the test bar so that it will average any uneven stretch between the two sides. This is accomplished by mounting the lower points of attachment in a frame that can swivel about its center. With the apparatus a block is supplied with which a specimen is quickly and accurately center punched 2 in. apart at opposite ends of a diameter.

To attach the extensometer it is taken in hand with the forefinger through the hole shown under the top frame and the thumb resting on the clip above the top



EASILY ADJUSTED TO PUNCH MARKS

frame. The hardened contact points are thus brought about 2 in. apart; the instrument is put up to the bar and with the other hand the screws are quickly set in the marks. The dial of the indicator can be rotated with the fingers at will so when the specimen with the extensometer attached is in the machine ready to begin testing, the dial is moved until the pointer stands over zero and test is begun.

It is apparent that no electrical contacts have to be bothered with and no adjustment of a micrometer screw made. The instrument has sufficient motion to carry the test well beyond the elastic limit before it must be removed.